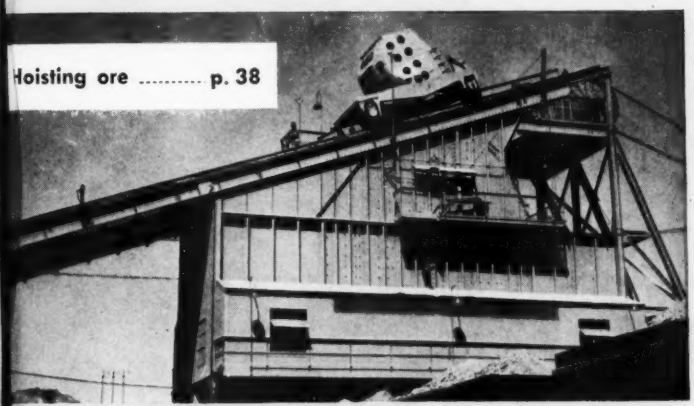
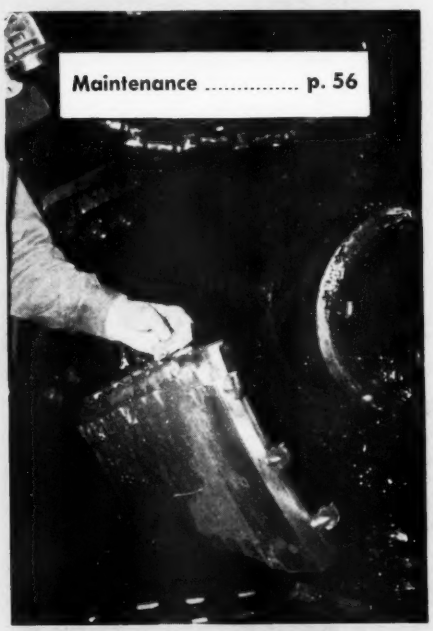
MINING CONGRESS JOURNAL

MARCH 1960

IN THIS ISSUE . . .





ALSO . . .
on pages
84 to 91
Advance Program

AMC
COAL CONVENTION

Here's how

DENVER

ORE TEST SERVICE

Can Save Money for You!

Profitable ore treatment is the challenge facing all mill operators. DENVER Ore Tests tell how to treat your specific ore to get greatest economic recovery and profit. We have complete laboratory testing facilities to produce laboratory results that can be duplicated by full scale mill machines.

COMPLETE SERVICE FROM ONE SOURCE

DENVER will investigate your ore... determine how to treat it... determine whether it can be treated commercially at a profit ...develop flow sheets... design the mill... provide construction drawings... supervise actual construction... provide start up service... and complete follow-through.

DENVER Ore Test Service is world-renowned and respected by banks, financial backers and government bureaus for accuracy and reliability. It is a simple, low-cost way to assure your milling profits—to remove the risk from mining investments. You will have problems in crushing, grinding, settling and possible concentration and filtering. These are our specialities so please let us help you in our Test Department.

Write, giving details of your problems for a complete recommendation

"The firm that makes its friends happier, healthier and wealthier"

ENGINEERS STANDARD RELIABLE 24 HOUR SERVICE EFFICIENT

DENVER EQUIPMENT COMPANY

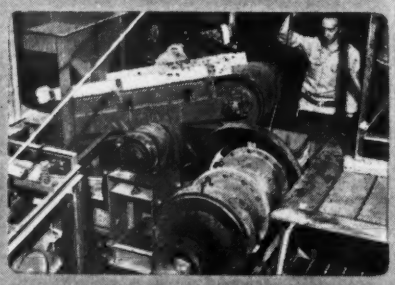
Cable DECO DENVER

Phone CHerry 4-4466

1400 Seventeenth St. Denver 17, Colorado

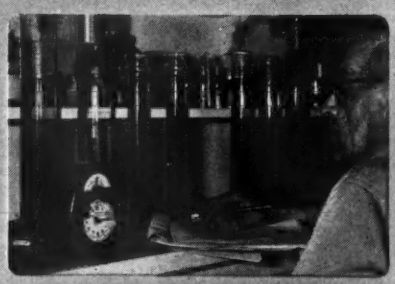
DENVER ORE TEST SERVICE INCLUDES:

PRELIMINARY INVESTIGATIONS

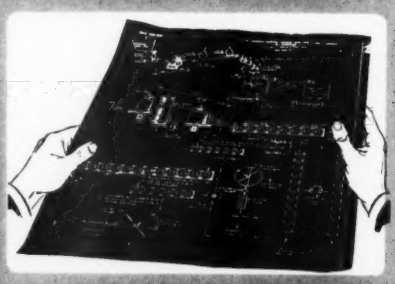


CRUSHING AND GRINDING TESTS

CONCENTRATION AND FLOTATION TESTS



SETTLING AND THICKENING TESTS



REPORT AND FLOWSHEET DEVELOPMENT

MINING CONGRESS JOURNAL

VOL. 46 MARCH 1960 NO. 3

Indexed regularly by Engineering Index, Inc.

CONTENTS

Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

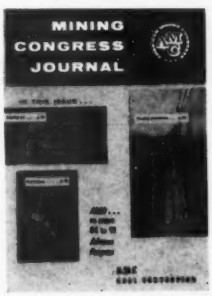
ARTICLES

DEPARTMENTS

SPECIAL SECTION

On Our Cover

Views of three operations which are described in articles in this issue — (below) maintenance of continuous mining equipment at Eastern Gas and Fuel's Federal No. 1 mine — (upper left) Kennecott's new skip hoist at the Liberty pit — (right) pumping concentrates from INCO's Creighton mill.



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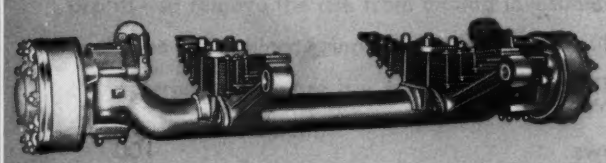
KW-DART 30-S

SPACE Problem?



Rugged Wide Track Front Axle.
The ruggedness and high capacity of this front axle assure long life and dependability. Wide track (113") permits oversize tires—no loss in turning angle and a high degree of stability.

30-Ton Payload—this is real capacity in a two-axle truck. Tires are same size front and rear, deliver maximum flotation and can be interchanged.

Space for load capacity and space to maneuver are problems. KW-DART has the answer to both in their Model 30-S.

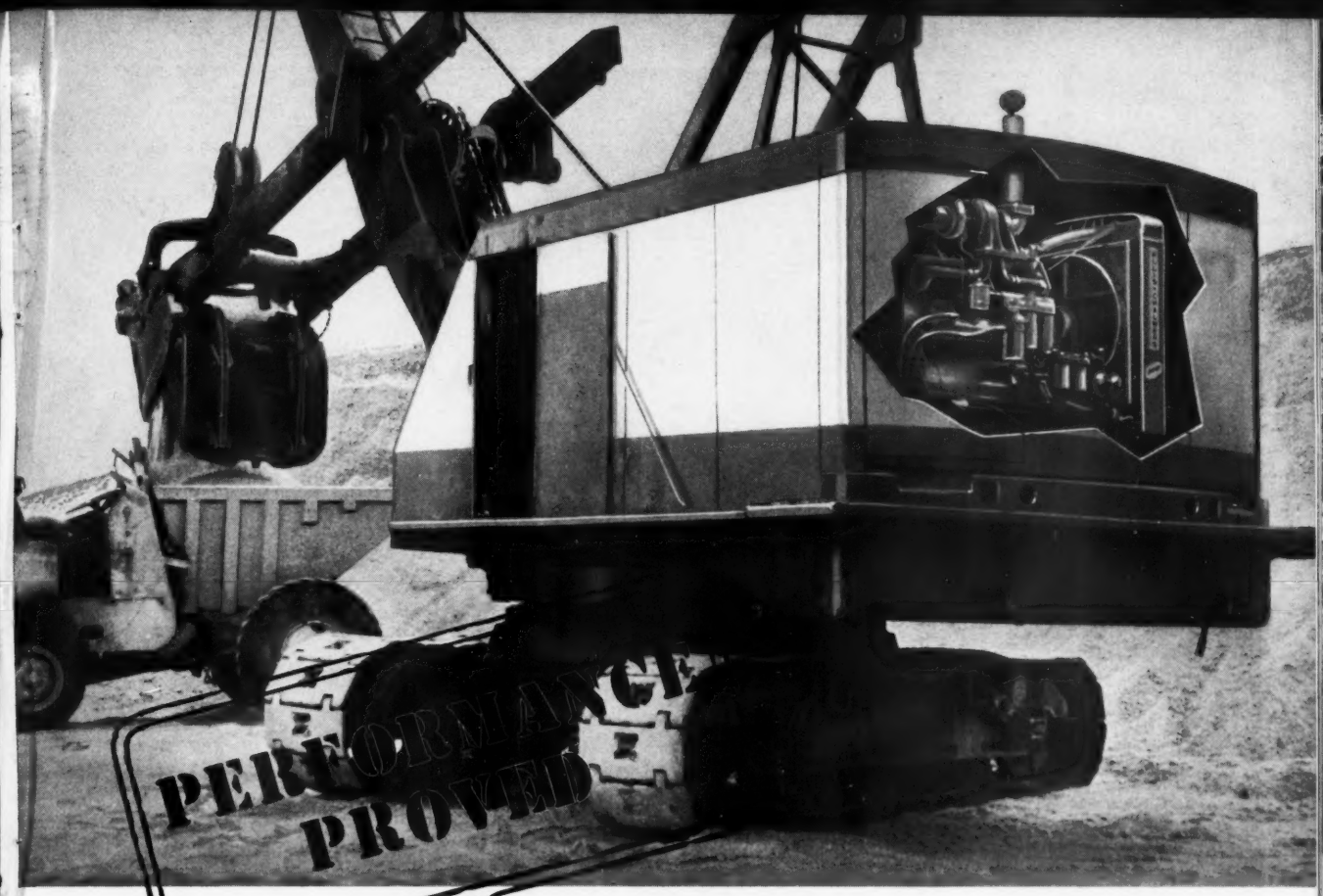
Short Wheelbase—compact, close coupled design with greater turning angle of the front wheels makes the KW-DART 30-S highly maneuverable in limited space at the shovel or hopper . . . and in tight turns on the road. The unusually short turning radius is only 28 feet.

KW-DART TRUCK CO.

1301 North Manchester Trafficway
Kansas City 41, Missouri, U.S.A.
Cable Address: DARTRUCO

P.O. Box 157

158



"We tried burying the bucket in the bank but couldn't... thanks to that 21000 diesel"

— That's a comment on performance of the Allis-Chalmers 21000 diesel repowering a 2½-yd shovel belonging to the Electro-Metallurgical Co., Ltd., Killarney State, Ontario.

PERFORMANCE PROVED

"It now seems to have twice the power," says the operator of a Pennsylvania-owned machine in which a 16000 diesel replaced the original engine of another make.

PERFORMANCE PROVED

"17% less fuel, 30 minutes less trip time" — These are the savings effected when a 21000 diesel repowered a truck operated by a logging company in Idaho.

PERFORMANCE PROVED

"Plenty of reserve, with economy and dependability to boot," states the owner of Minnesota Construction Company, who has several pieces of equipment powered by 16000 and 21000 diesels.

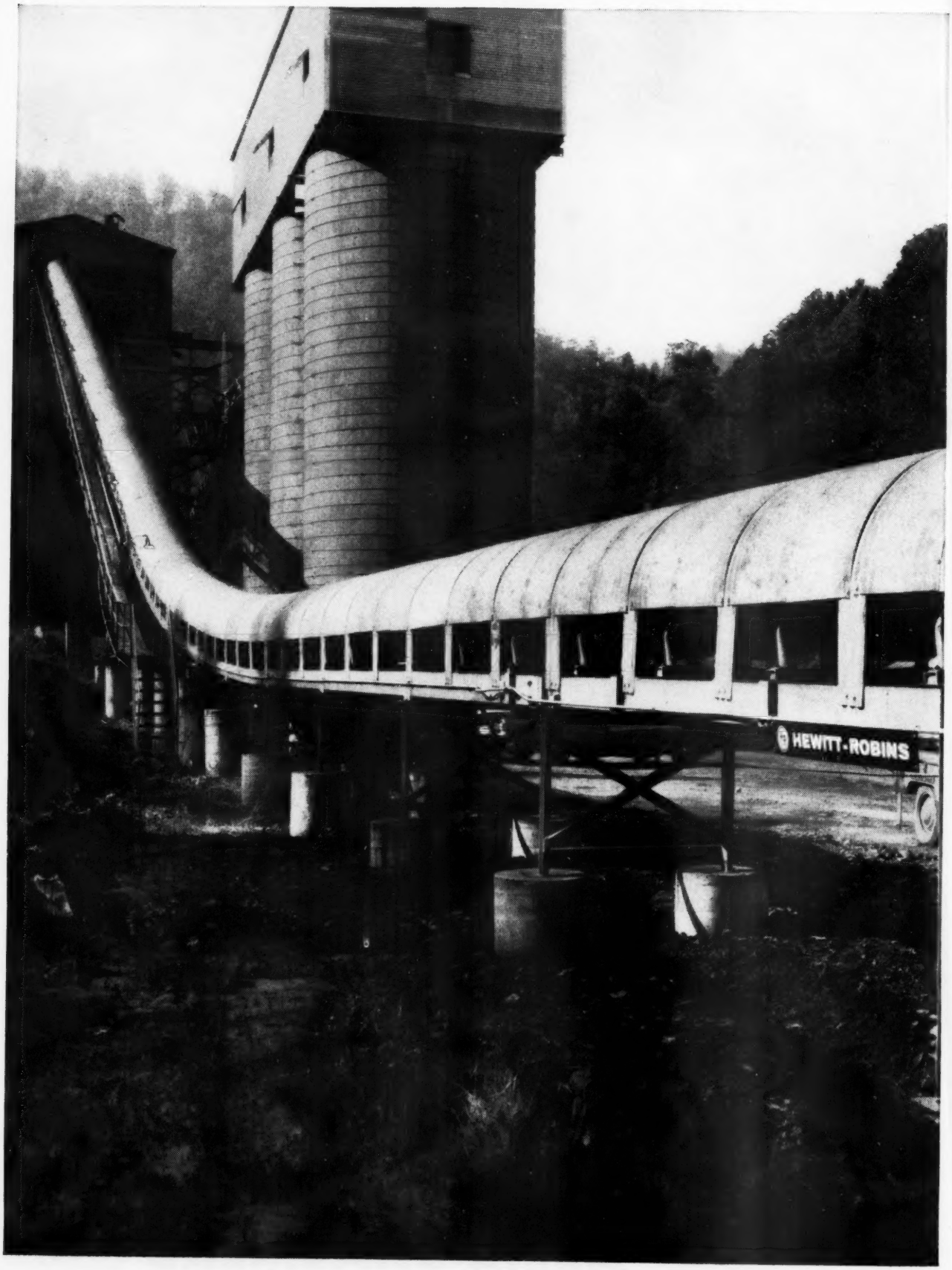
"We can hardly believe the fuel economy" — "'Startingest' engine we ever had" — "Don't understand why anyone would want an old-fashioned 'smoker' again," comment others. Everywhere, on every type of installation, the amazing 16000 and 21000 are "performance proving" their greater economy, their top usable power, their superior starting. If you want diesel advantages like these, see your Allis-Chalmers dealer for details. Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

***POWER* FOR A GROWING WORLD**

A-C ALLIS-CHALMERS

BC-25


HEWITT-ROBINS

How to move 194 pounds of rock and coal per second

Hewitt-Robins conveyor belting of high-tenacity Enka rayon gives a graphic demonstration of its superior performance

Here in Whitewood, Virginia, the Jewell Smokeless Coal Company moves 350 tons of rock and coal every hour. To keep operations at peak efficiency, they employ a Hewitt-Robins sectional conveyor and Hewitt-Robins belting.

The 462 foot section of the conveyor, shown here, carries rock and coal into the preparation plant. This Hewitt-Robins belt is Ajax 36″ C/R (cotton/high-tenacity Enka rayon) construction.

Once again, Hewitt-Robins conveyor belting of high-tenacity Enka rayon yarn and cotton demonstrates its superior performance and smooth-running efficiency. Here is another reason why, year after year, Hewitt-Robins continues to specify Enka rayon. Hewitt-Robins and other quality manufacturers know that high-tenacity, low-cost Enka rayon is made stronger to last longer.

Pound for pound, Enka high-tenacity rayon is your best value in industrial yarn.

Greater strength • More elasticity • Increased heat and humidity resistance • Higher safety factor • More economy • Superior flexibility • Better shock absorbency • Longer service • Less maintenance.

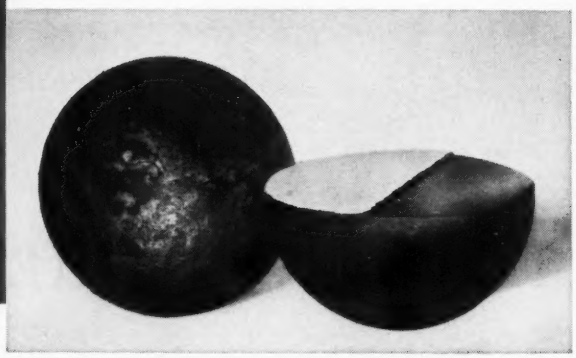
Specify Enka high-tenacity rayon yarns for industrial rubber products, chafer fabrics for truck and passenger tires, heavy-duty sewing thread for multi-wall bag closing and many other vital end-use applications.

Write for Hewitt-Robins brochure on C/R conveyor belting of high-tenacity rayon and cotton. It gives technical data on strength and other characteristics of belting made with cotton-rayon fabric. Write Hewitt-Robins, Stamford, Conn. Ask for bulletin 3-15.

ENKA high-tenacity rayon for industry

American Enka Corporation, 530 Fifth Avenue, New York 36, N. Y.
Leading producer of yarns and fibers for apparel, home and industry and Tyrex® viscose tire yarn.

New steels are born at Armco



consistently

UNIFORM

fine grain structure

You can depend on it. Sheffield's alloying, forging and heat treating techniques assure a uniformly dense grain structure—a fine balance of hardness and toughness—right to the very core of every Moly-Cop Ball. That's why Moly-Cops retain their sphericity longer, to give you a better, longer grind at the lowest cost per ton.

The Standard of Comparison Around the World

SHEFFIELD
ARMCO
MOLY-COP
COPPER-MOLYBDENUM-ALLOY
Grinding Balls

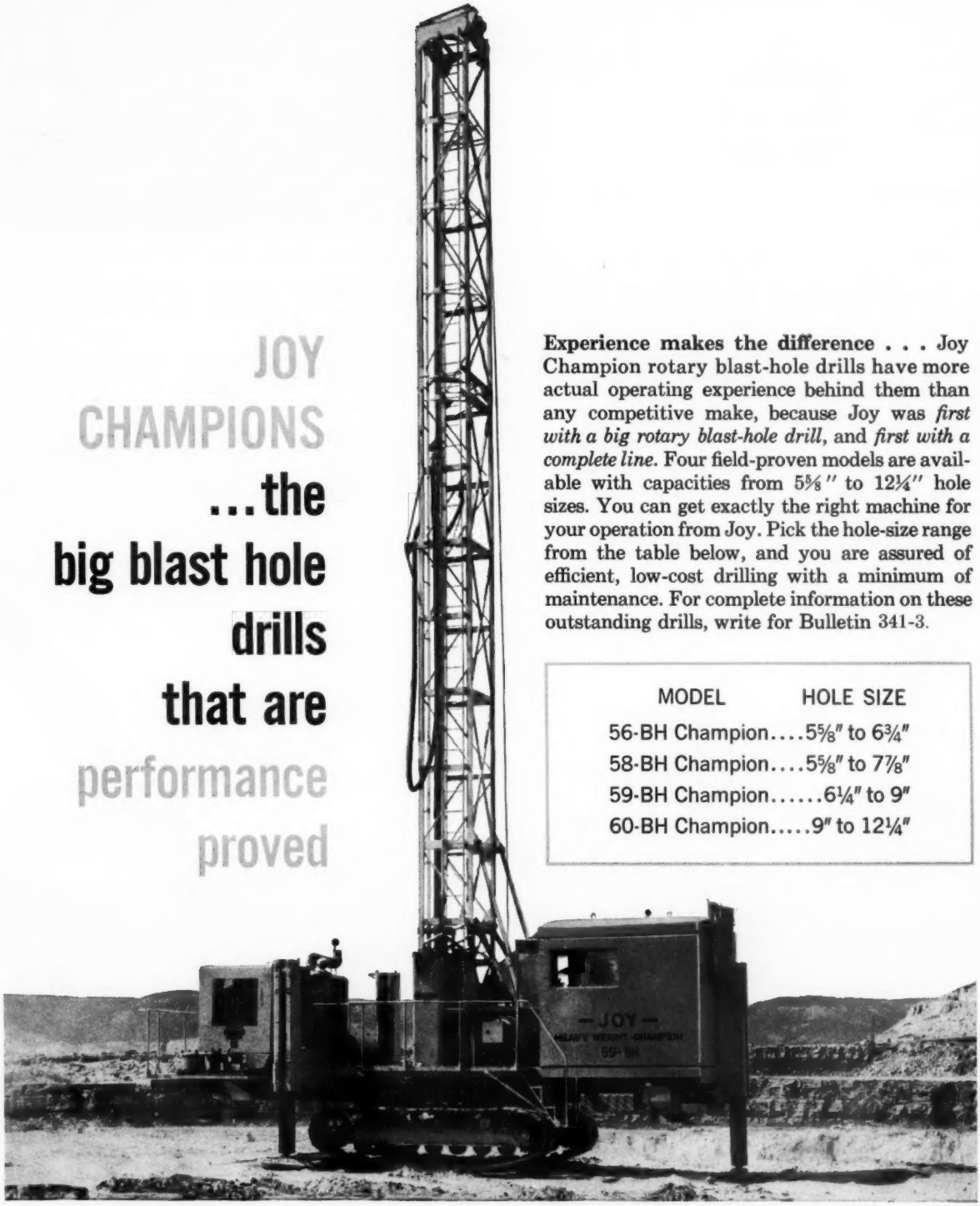
SHEFFIELD DIVISION

Sheffield Plants: Kansas City, Houston, Tulsa

ARMCO STEEL CORPORATION

OTHER DIVISIONS AND SUBSIDIARIES: Armco Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

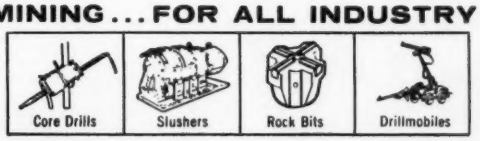
JOY CHAMPIONS ...the big blast hole drills that are performance proved



Experience makes the difference . . . Joy Champion rotary blast-hole drills have more actual operating experience behind them than any competitive make, because Joy was *first with a big rotary blast-hole drill*, and *first with a complete line.* Four field-proven models are available with capacities from 5⅝" to 12¼" hole sizes. You can get exactly the right machine for your operation from Joy. Pick the hole-size range from the table below, and you are assured of efficient, low-cost drilling with a minimum of maintenance. For complete information on these outstanding drills, write for Bulletin 341-3.

MODEL	HOLE SIZE
56-BH Champion	5⅝" to 6¾"
58-BH Champion	5⅝" to 7⅞"
59-BH Champion	6¼" to 9"
60-BH Champion	9" to 12¼"

EQUIPMENT FOR MINING... FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

Kolbe wheel moves 3,500 cubic yards of overburden per hour, discharges load more than 420 feet away.

How Cuba Mine saves on cost of lubricating the Kolbe wheel

Only 9 products to do all lubricating jobs on earthmoving giant

Cuba Mine management knows how to hold down operating costs—including lubrication. Standard Oil lubricants are used throughout on the Kolbe wheel.

Here's how money is saved on lubrication of the Kolbe wheel: (1) The best lubricants and greases are used. This means lubrication breakdowns don't happen. Thus, idle plant charges are eliminated. Lubricants and greases last longer. So do motors and parts. (2) Quality products do more jobs. With only nine products, savings are made in handling and inventory. There are fewer products to train men to apply and fewer chances of application mistakes. (3) One source means one responsibility for keeping the mine supplied with the petroleum products needed. And from one source mine management can get responsible lubrication technical assistance, and they can get it in a hurry. Ken McDaniel, the mine's Standard Oil man, lives less than 45 miles away.

The lubricants and greases that will save you money and the technical assistance to show you how to use them are available from Standard Oil. Call our office near you anywhere in the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

STANDARD

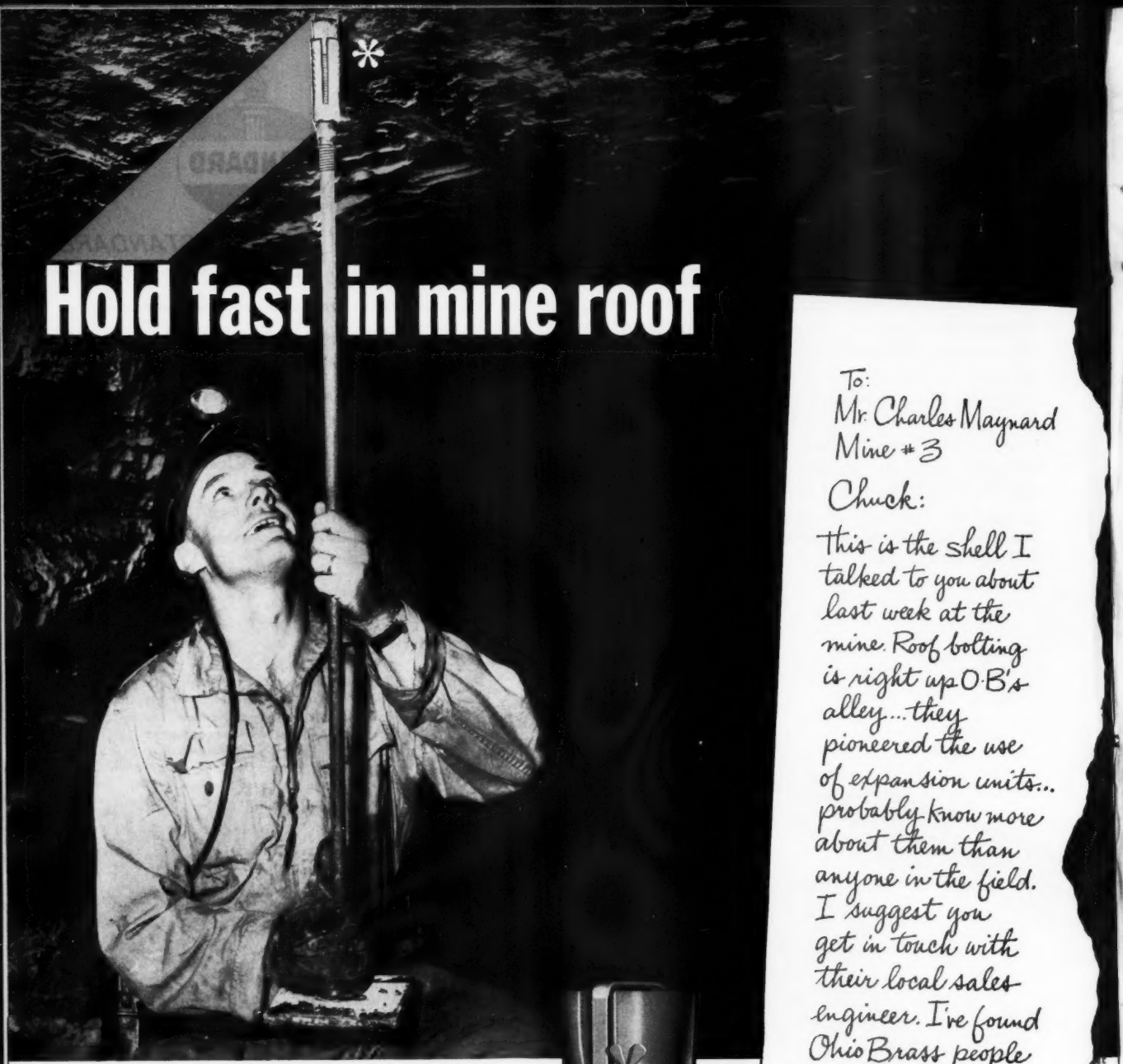
You expect more from STANDARD and you get it!

Lubricants and Greases used on the Kolbe Wheel

STANOGEAR Compound Nos. 3, 5, 6, 8
RYKON Grease No. 2, E. P.
CALUMET Viscous Lubricant
STANOLUBE HD Moly Grease
STANOIL Industrial Oil
INDOIL Industrial Oil No. 15

Standard Oil lubrication specialist Ken McDaniel (right) checks out lubrication needs with Cuba Mine superintendent Cecil Clayberg. This is work for which Ken is well equipped. He has six years' experience in such work plus an engineering degree from the University of Illinois. In addition, he has completed the Standard Oil Sales Engineering School.

Hold fast in mine roof



To:
Mr. Charles Maynard
Mine #3

Chuck:

This is the shell I talked to you about last week at the mine. Roof bolting is right up O-B's alley... they pioneered the use of expansion units... probably know more about them than anyone in the field. I suggest you get in touch with their local sales engineer. I've found Ohio Brass people are glad to work right with you in the mine.

Regards,
Jack

Ohio Brass 4-Way Expanding Anchors hold in both soft shale and hard rock

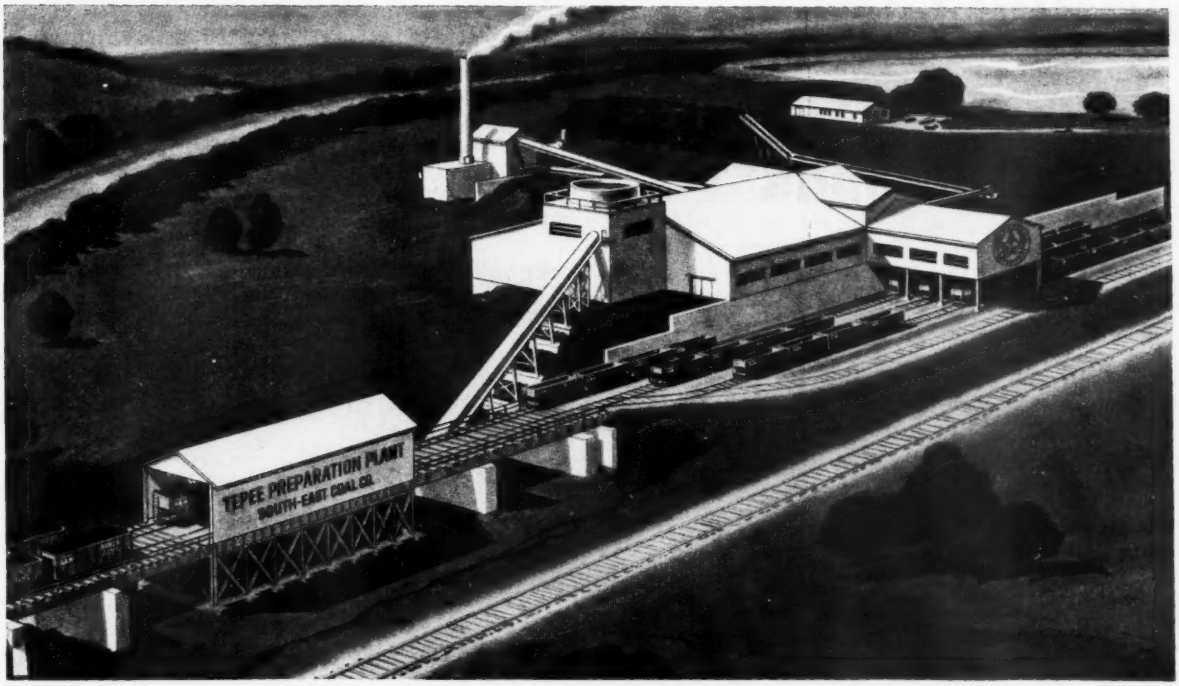
- **GO UP FAST** . . . 4-way expansion begins with the first turn of the wrench.
- **DEVELOP TOP HOLDING POWER** with easy wrenching effort . . . 150 "foot pounds" of torque gives bolt tensions of 9000 pounds.
- **WORK IN CLOSE QUARTERS** . . . O-B engineers developed these anchors underground. Personal knowledge of mining problems enabled them to design units that are especially suited to your needs.
- **GET SERVICE** for your roof bolting problems . . . see your local Ohio Brass engineering representative or write Ohio Brass Company, Mansfield, Ohio.

O-B Bail Type Expansion Shell and Plug

Ohio Brass HOLAN

EXPANSION SHELLS AND PLUGS • LINE MATERIALS • SAFETY AND CONTROL EQUIPMENT • ELECTRIC HAULAGE MATERIALS

a new concept in COAL PREPARATION PLANT DESIGN



Artist's view of the new 900 TPH Coal Preparation Plant for South-East Coal Company, Irvine, Kentucky

In close cooperation with the Kentucky Engineering and Materials Company, prime contractors for the South-East Coal Company, Heyl & Patterson is executing plant lay-out and design engineering for the Fine Coal Preparation and Water Clarification Plants, based on H & P's flow sheets.

Heyl & Patterson was entrusted with this role on the strength of its pioneering in new and improved coal preparation methods and because it has developed the equipment necessary for these better practices.

The unique split-level design of South-East Coal Company's new coal preparation plant utilizes the topography to achieve substantial savings in excavation and foundation costs.

When it is completed, this plant will process 900 TPH of 6" x 0 coal with equipment selected for economy and performance. Much of this equipment is the product of Heyl & Patterson's research program for the development of advanced coal preparation machinery and processes. For instance, the H & P Fluid Bed Dryer in this installation is the largest single unit thermal dryer ever built.

Discuss your new coal preparation requirements with H & P engineers who will gladly assist in an earnest search for solutions best suited to your own operating and marketing conditions.

Depending on your needs, you will receive from us a proposal either for a "turn-key" job or a cooperative effort, similar to the one proving so successful for the South-East Coal Co.

When experience counts . . . count on Heyl & Patterson.

HEYL & PATTERSON, inc.

55 FORT PITT BLVD., PITTSBURGH 22, PA.

H&P

Question 1:

What's <u>different</u> about Haulpak®?

ANSWER: The LW Haulpak is like other off-road trucks *only* because it has wheels and an engine! Otherwise, its design is completely different... for your benefit. For instance:

RIDES ON AIR — Other trucks ride on steel springs that need much attention. Haulpak eliminates this major cause of downtime with the exclusive LW HYDRAIR* suspension system. With it, Haulpak *rides on air*... the load rides smooth and level on rough roads. You can safely use faster hauling speeds, move more tons per hour. Hydrair also makes possible many other advantages:

SHORTER TURN RADIUS — Because Hydrair suspension eliminates need for conventional springs and

Notice the deep "V" body which permits Haulpak to carry about 25% of its load *below* what would be the floor line of a conventional hauler. This gives greater stability, permits faster travel on turns and steep grades. ▶

Here's HYDRAIR

This sturdy, simple air-hydraulic suspension replaces the usual leaf springs found in conventional off-road equipment, relieving Haulpak owners from expensive spring repair and maintenance. Hydrair cushions against loading and travel shocks, compensates automatically for off-center loading, and keeps the load riding level over bumps and holes, for faster, more profitable hauling cycles.

Question 2:

How does Haulpak <u>save you</u> money?

ANSWER: From the answers above you can easily see how this all-new hauler *saves* on hauling costs, gives you:

- **greater maneuverability**
- **lower operating cost**
- **lower maintenance**
- **faster hauling**
- **more pay-tons per hour**
- **...and bigger profits**

front axles, Haulpak's front wheels can be turned at sharper angles . . . permits U-turns in 2/3rds the space required by competitive trucks. And without need for springs and axles, Haulpak can be built with a shorter wheelbase for more efficient transfer of power-to-wheels. There is, however, no loss in load capacity, because you get the LW exclusive . . .

DEEP "V" BODY — This permits carrying about 6 tons of material *below* the normal floor-line of conventional trucks. It also gives you a lower center of gravity, better stability on turns and steep grades.

HAULS THROUGH DEEP MUD — Haulpak is equipped with the famous LW power-transfer differential, used for many years in thousands of heavy-duty Tournapull® earthmovers all over the world. When one drive wheel begins to slip, power is transferred automatically to the wheel on firmest footing. Soft going does not stop Haulpak!

MANY OTHER MONEY-SAVERS! You save on fuel, because Haulpak is built of the newest lightweight high-tensile strength steels . . . to reduce deadweight and increase pay-load. Also, Haulpak gives you power-shift Torqmatic transmission, full power-steering, multiple-disc brakes with 5,148 sq in. total braking surface, double-acting hydraulic rams that lift body to 70° tilt in 16 seconds for fast dump. And lubrication check is reduced to only 3 easily-reached fittings needing attention only at 500-hr intervals. Haulpak is not just a "beefed-up" highway truck . . . it is a totally new concept developed to cut off-road hauling costs.

Next time you need an off-road hauler, investigate Haulpak. Now available in 3 sizes: 22, 27, and 32 tons capacity. Request literature, and ask to see our new color movie, "*Revolution on Wheels*".

*Trademark HP-2261-G-2

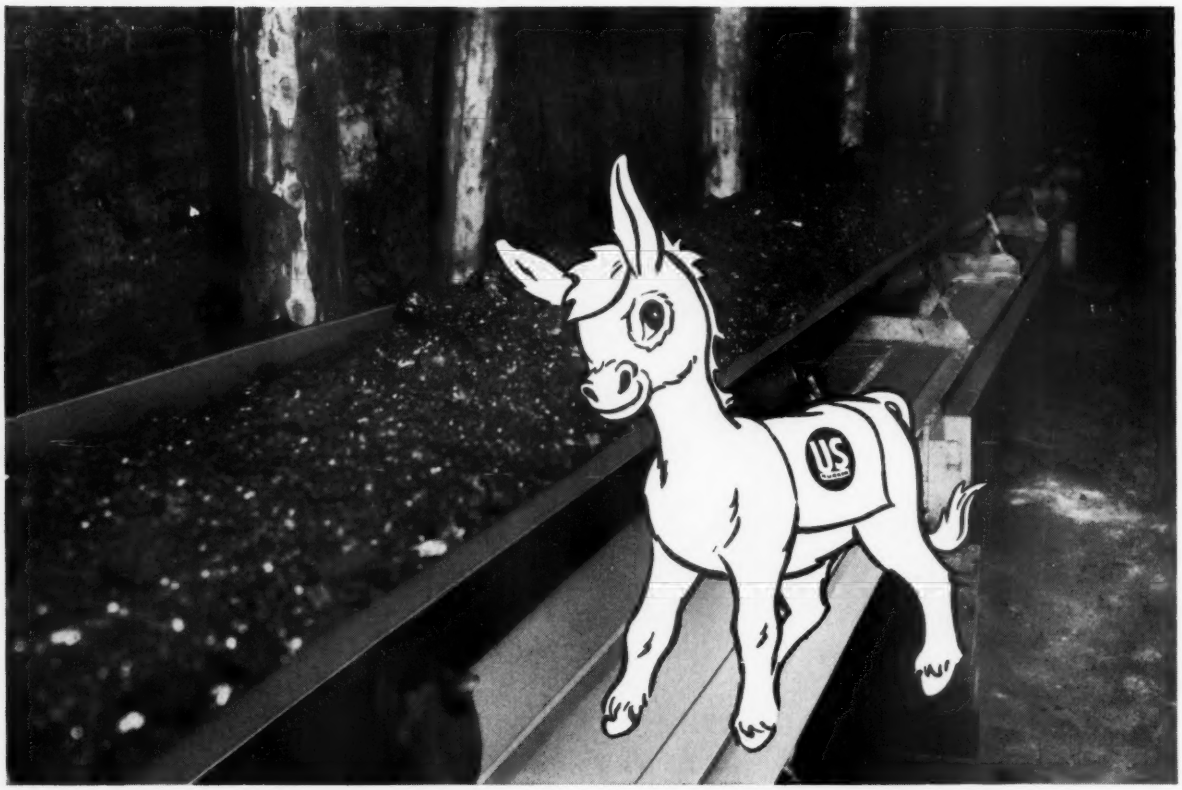
LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

BURRO CONVEYOR BELT

INTRODUCING THE BURRO



The First PERFECTED interwoven coal mine belt!

Like its namesake, U.S. Burro® Conveyor Belt needs no coddling. It's tough – all the way through. This INTERWOVEN belt has been perfected with the mine operator in mind and offers these features:

a) Exclusive engineered stretch control, **b)** any cover thickness available, **c)** widest operating temperature range, **d)** highest edge and lengthwise rip resistance. **e)** Excellent fastener holding ability, **f)** perfect troughability for easy training, **g)** lowest cost.

This perfected U.S. Burro interwoven coal mining belt is ready for you now at your United States Rubber Distributor. He has *the complete line* of "U. S." materials-handling belts.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

Cut pit costs with Tournatractor®...

It travels faster ...works faster

For your *own* satisfaction, determine the money-saving advantages you get with a big LeTourneau-Westinghouse Tournatractor. Do some stop-watch-timing on this tractor and compare its performance with any tractors you may *now* own.

You'll find, if assigned to clean-up duty around a number of scattered shovels for instance, that a track-type tractor spends much of its time just traveling between jobs. And travel time accomplishes *nothing.* It only adds to your operating costs. Or, if you assign one tractor to *each* shovel, you'll notice that here, too, there's liable to be a lot of waste time, because there isn't enough work to *keep one tractor busy.*

Fast work and travel speeds offer a big advantage

With Tournatractor, you cut tractor "travel overhead" by more than half. That's because, on job-to-job travel, Tournatractor moves more than twice as fast as the fastest crawler tractor. It runs between assignments . . . at speeds to 17 mph! You'll find a single rubber-tired LW tractor handles more work over a wider area than *2 or more crawler tractors!*

And because Tournatractor is fast, don't get the idea it's just a "hit-and-run" flyweight. Not on your life! It's got the sock and ruggedness of a true "heavy". With 218 hp and up to 15 tons of work-weight, it can match production with any tractor its size. Use an LW tractor for shovel clean-up . . . for spotting rail cars . . . for fast push-loading or towing service . . . for heavy construction or dozing to improve haul roads and drainage. You'll also find Tournatractor a "natural" for compacting stockpiles, because when those big tires are hydroflated, Tournatractor provides compaction equivalent to an extra 20-ton roller.

Let us show you how Tournatractor can fit into *your* operations. See how this fast, mobile machine can help you cut costs in a hurry!

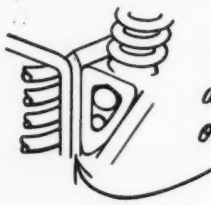
CT-2202-MQJ-1

This Tournatractor is one of 3 owned by Bagdad Copper Corp., Bagdad, Arizona. At its open-pit mine the firm works LW tractors 16 hours a day to clean-up around shovels . . . to maintain waste dumps and haul roads . . . to tow stalled trucks and other equipment. Says Mine Superintendent Edward L. Jones, "Our Tournatractors complete a variety of scattered jobs over a wide area fast!" Operator Edgar D. Owings adds, "I sure like the torque converter on this tractor and the big low-pressure tires have more traction, make it smoother riding, too."

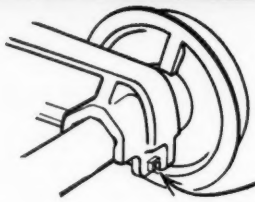
LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

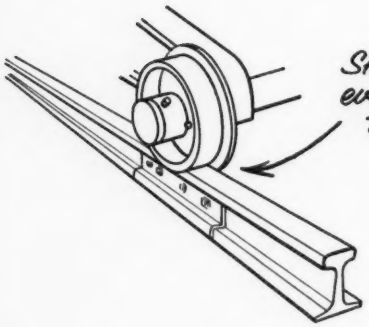
Where quality is a habit



Movement between bolster and side frame is taken on specially designed wear surfaces

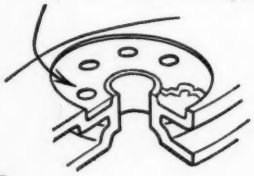


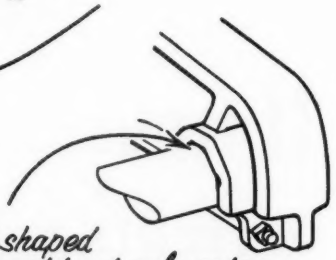
Quick wheel change



Smoother ride even on rough tracks

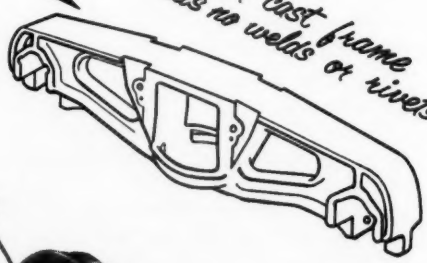
Large center bearing for longer life





V-shaped machined axle grips for controlled flexibility and truck alignment

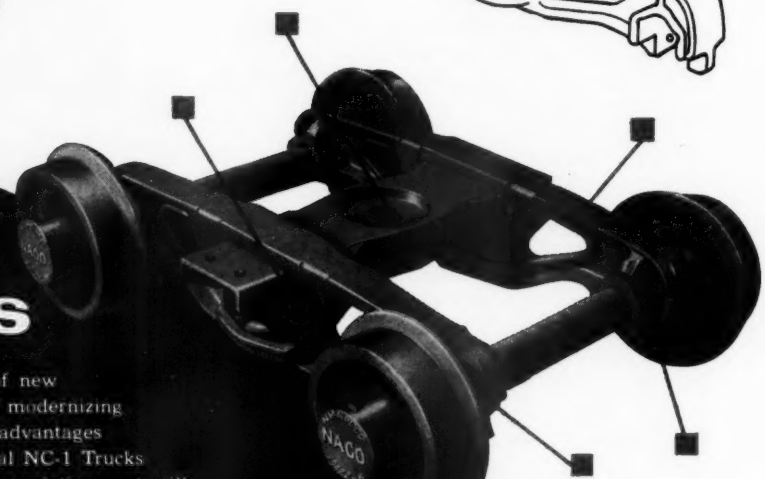
Integral cast frame has no welds or rivets



Check these "plus" features

OF

NATIONAL NC-1 TRUCKS



If you're considering the purchase of new 8-wheel mine cars . . . or if you're thinking of modernizing older cars—*now* is the time to check the advantages of National NC-1 Trucks. National NC-1 Trucks have controlled flexibility for track variations yet still maintain truck alignment through their machined V-shaped axle grips. In addition, NC-1 Trucks have a built-in shock absorbing mechanism.

You get more out of your mine car investment per workshift . . . per day . . . per year. And at the same time you minimize spillage . . . get greater protection for your equipment, track and structures . . . slash maintenance to a new low.

Yes, *now* is the time to check National NC-1 Trucks—they make sense for 8-wheel mine cars . . . *make dollars for operators*, too.

- WILLISON AUTOMATIC COUPLERS
- RUBBER CUSHIONED UNITS
- NC-1 CAR TRUCKS • NACO STEEL WHEELS
- NACO STEEL LINKS & SWIVEL HITCHINGS

AA-5077

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868 — *Cleveland 6, Ohio*

"I call Bethlehem when I need track spikes fast. They carry all standard sizes in stock, ready to go at a moment's notice."

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Tandem trailer units, with a Mack LRX Model doing the hauling, keep the pressure on 3¼-yard electric shovel at the Maryland quarry of North American Cement Corporation.

MACK
for over 7 straight years
NO. 1
by far in sales of diesel trucks

Maneuverability and ease of handling are Mack features which have made them favorites for heavy-duty quarry work. Here 28 tons of rock is unloaded at the crusher located a half-mile from quarry face.

At the Security Plant of North American Cement Corporation...

TWO MACKS

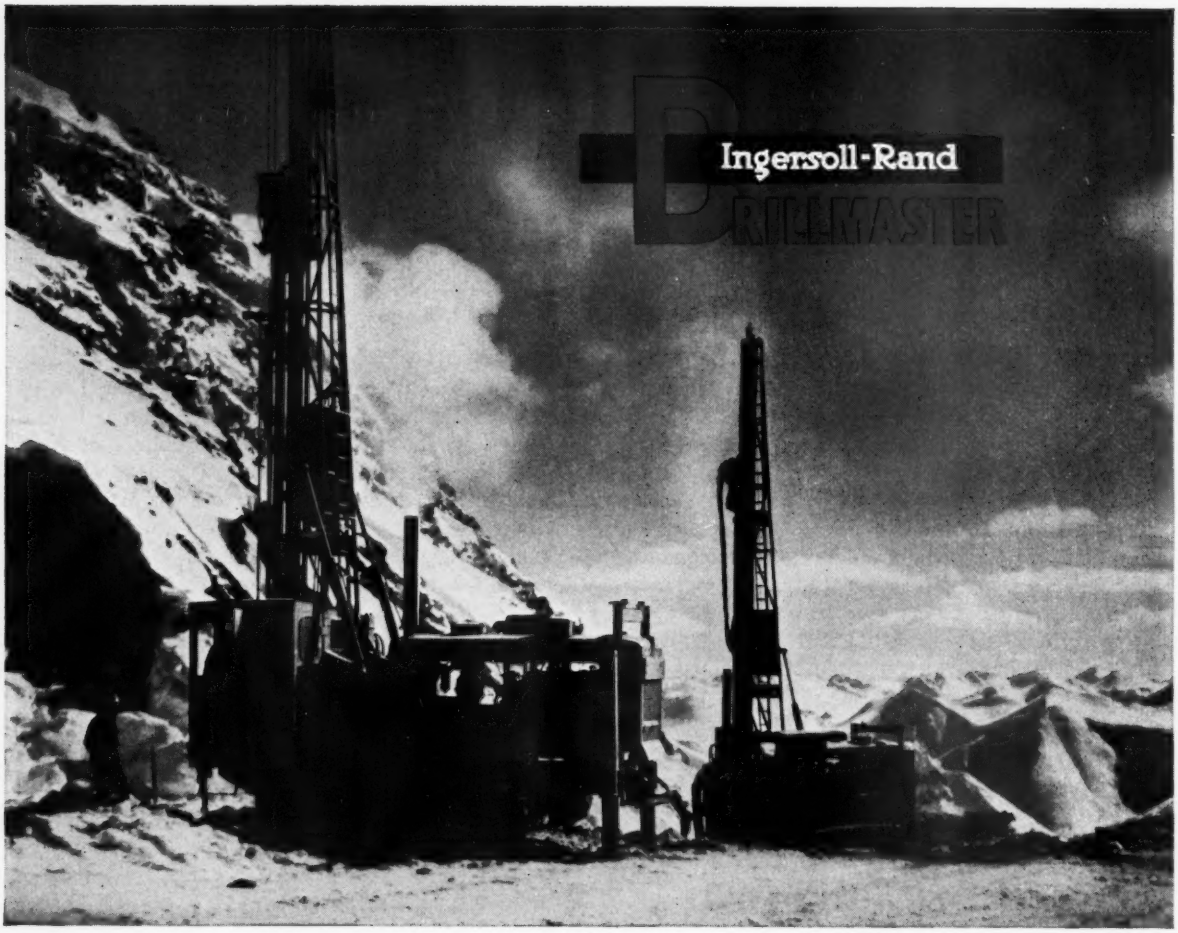
handle half a million tons of rock per year

North American Cement Corporation has jumped hauling capacity and still kept down costs at its Security Plant in Hagerstown, Md., by coupling full trailers with LRX Model Macks. Each of the two rigs now handles 28 tons at a clip—together they will move 500,000 tons of limestone this year.

The quality of Mack-built engines, transmissions, and clutches helped sell North American Cement on Macks—for, like suspensions, rear axles and other vital components, they are engineered and built by Mack for Mack trucks alone. Mack has manufactured its own components—to the highest standards in the industry—for over 60 years. Manufacturing craftsmanship and the famous Mack practices of Balanced Design account for the fact that a Mack truck will stand up under fast-moving shovels, heavy loads and poor going better than any vehicle in its class. Wouldn't these qualities be valuable in your operation? Your nearest Mack branch or distributor is the man to see. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

7414

MACK
FIRST NAME FOR
TRUCKS



I-R Drillmasters average 100 ft. per shift, 24 hours a day, in MILE-HIGH ASBESTOS QUARRY

At an elevation of 6200 feet on a spur of McDame Mountain in British Columbia, the Cassiar Asbestos Corp. is mining 2500 tons of ore and removing an additional 3000 to 5000 tons of overburden each day. Here, in sub-zero temperatures, crews work around the clock in three shifts, 7 days a week during the so-called "summer".

To maintain high production during the mining season, two I-R DM-3 Drillmasters with Downhole Drills and 6½" Carset bits are in continuous use, averaging 100 feet per drill shift. Holes are put down 33', spaced 16½' apart with 15' burden, resulting in 14.5 tons of broken rock per foot drilled, using 5x16" Dynamex cartridges, as well as prilled ammonium nitrate and fuel oil.

In this rugged, snow-covered terrain, the excellent traction and maneuverability of the crawler-mounted Drillmaster is a big asset, and its self-contained Ingersoll-Rand Gyro-Flo compressor provides maximum drilling pressure without air line losses from long lengths of piping or hose.

In warm weather or cold, at high altitudes or sea level, a Drillmaster is your best assurance of top drilling efficiency at rock-bottom cost. Ask your Ingersoll-Rand engineer for further information on its features and performance.

Ingersoll-Rand
11 Broadway, New York 4, N.Y. 6A5

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

"HH" HENDRIX

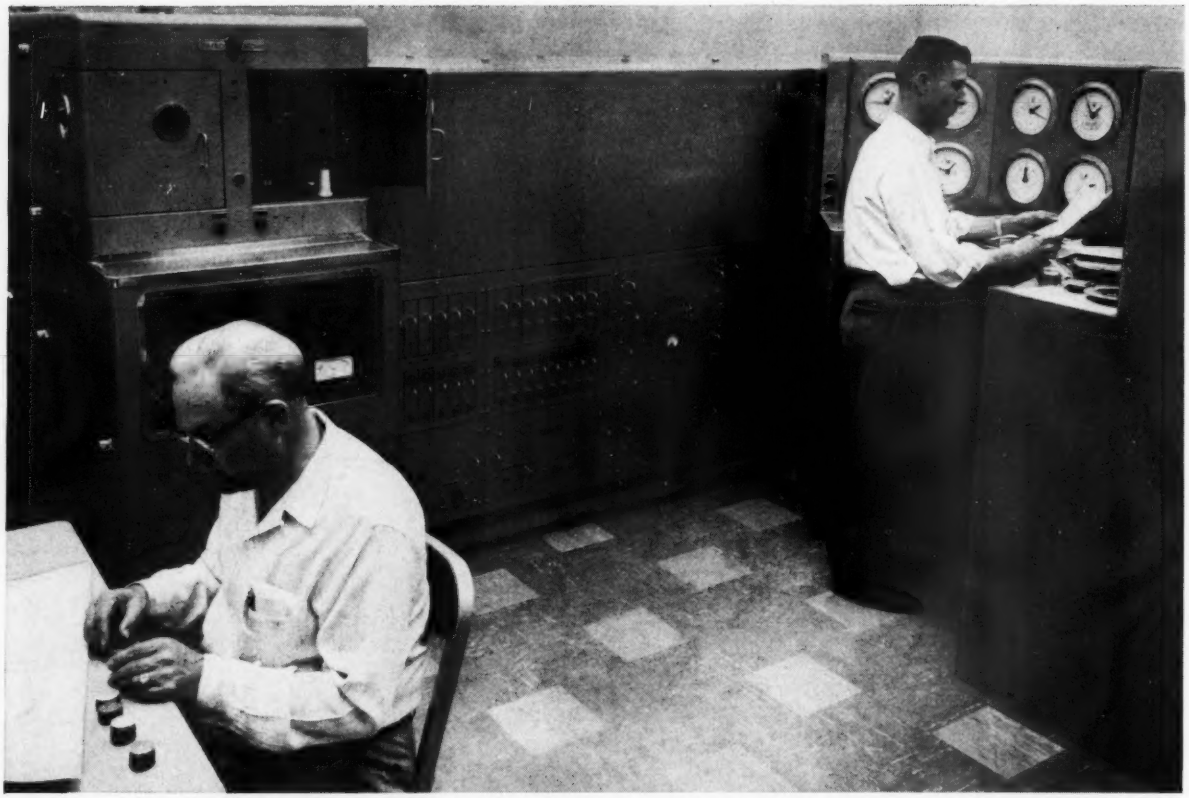
Heavy Duty Mining Buckets

- LESS DOWN-TIME
- MORE PRODUCTION
- LESS MAINTENANCE
- LOWER COST-PER-TON

4½ to 14 Cubic Yards With or Without Perforations

HENDRIX MANUFACTURING CO., Inc.

MANSFIELD, LOUISIANA



Accurate to one ten thousandth of one percent. With this new "Direct Reader" Spectrograph, CF&I maintains extraordinary control over each melt of steel. Samples, taken from the blast furnace or open hearth, are sped to the lab via pneumatic tubes. In minutes, a complete spectrographic analysis is ready. This "controlled chemistry" means Grinding Balls and Rods that wear longer, grind more efficiently.

What CONTROLLED CHEMISTRY means in CF&I Grinding Balls and Rods

CF&I takes great care in the selection of steels used in its grinding balls and rods. For example, each size ball from the smallest to the largest (¾" to 5" diameter) must have the proper composition to give the best balance between hardness and toughness. CF&I's modern spectrographic equipment assures you balls with the correct chemistry in relation to their size. In fact, CF&I uses different steels, depending on the ball size required. This chemical control pays off in your mill because CF&I balls have greater resistance to abrasion, withstand impact, and grind at lower cost.

In grinding rods, CF&I observes similar standards. Special analyses of high carbon steels are hot-rolled and machine-straightened to close tolerances, from 1½" to 4" diameter in whatever lengths ordered. CF&I's controlled chemistry techniques result in grinding rods that have excellent wearing properties, resisting bending or premature breakage.

For the complete story on the advantages of CF&I Grinding Balls and Rods, get in touch with your local CF&I Sales Office.

Other CF&I Steel Products for The Mining Industry

CF&I Mine Rail and Accessories • CF&I Rock Bolts • Realock Metallic Fabric
CF&I Industrial Screens • CF&I-Wickwire Rope • CF&I Grader Blades

CF&I STEEL

MINING PRODUCTS

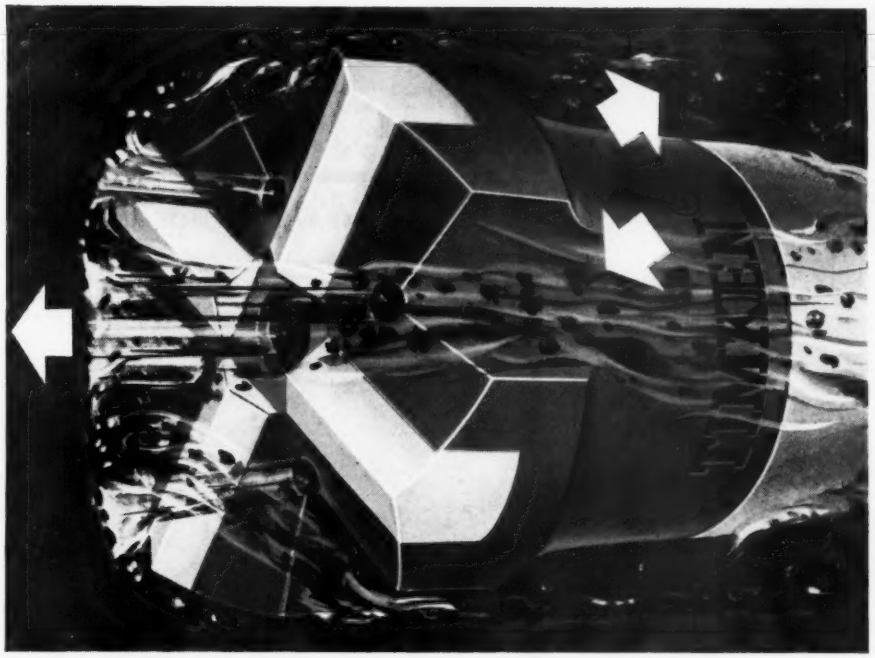
THE COLORADO FUEL AND IRON CORPORATION

7525

In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso • Ft. Worth • Houston Kansas City • Lincoln • Los Angeles • Oakland • Oklahoma City • Phoenix • Portland • Pueblo • Salt Lake City • San Leandro • Seattle • Spokane • Wichita
In the East: **WICKWIRE SPENCER STEEL DIVISION**—Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia

WIDER WING CLEARANCE

ALL AIR OR WATER SHOOTS FORWARD



Timken® threaded bits

CLEAR CHIPS FASTER

When you drill, you want to drill rock—not loose chips. You want to prevent wasteful chip-clogging. And you *can,* by using Timken® threaded carbide insert bits. The five front hole design, pioneered by the Timken Company, shoots air or water directly against the rock face to speed chip removal. And with the deeper, wider wing clearance chips clear faster. You save time, speed drilling.

You save in other ways too. The tough, special analysis carbide inserts have better wear resistance. They're deep—can be re-conditioned many times. And bit bodies are made of Timken fine alloy steel for added strength. Result is you get more hole per bit with your drifters, sinkers and stopers.

Timken bits are used by more miners and contractors than any other removable bit. One reason is that with Timken bits you get the kind of "on the job service" from Timken field engineers you can't get anywhere else. Timken threaded bits are available in a complete range of sizes and types. For full details send for free brochure,"Timken Removable Rock Bits". The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

FOR OTHER TOUGH DRILLING JOBS

ALL-STEEL MULTI-USE

This Timken bit gives lowest cost per foot of hole when you can drill out full increments of steel.

TAPERED SOCKET BIT

Tapered to give strength of one-piece steels. Has the same speedy chip-removal features as the threaded bit shown above.

TIMKEN®

removable rock bits

NEW 24" LOW

Fletcher ROOF CONTROL DRILL

with 51" FEED

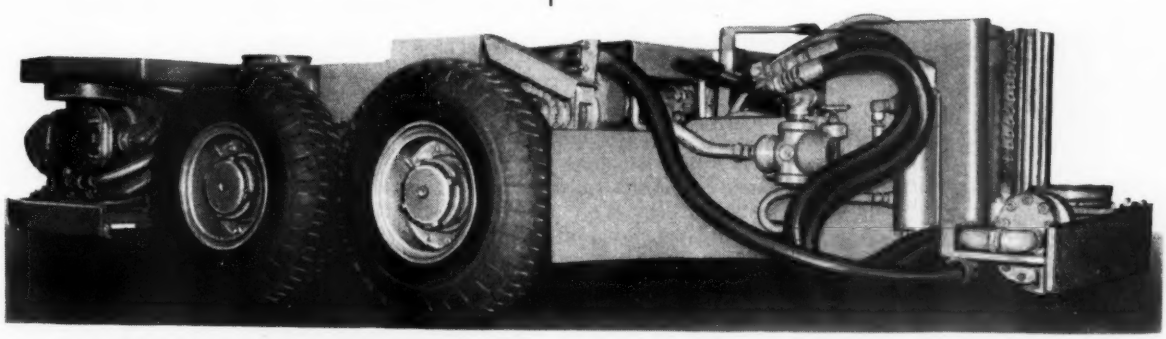
Delivers ALL the FEED YOU NEED

in a Drill designed especially for LOW COAL

A REMARKABLE DESIGN BREAK-THROUGH

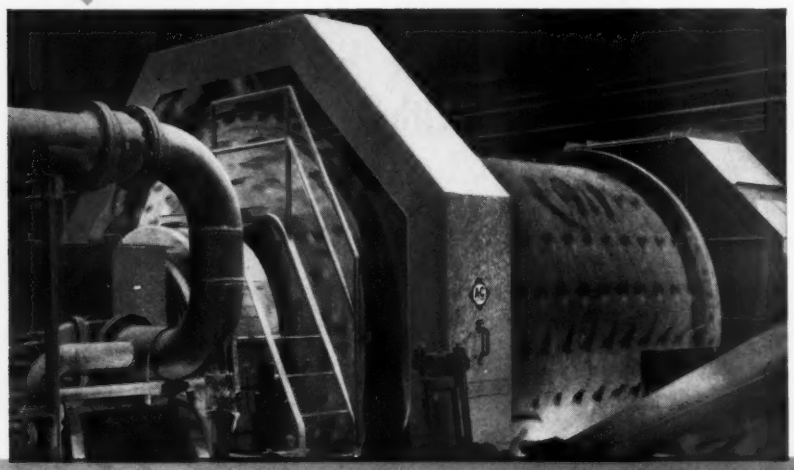
in this entirely new Fletcher LOW Roof Control Drill provides the dependable, high-thrust, straight-from-the-floor feed of the telescoping mast with TWICE the flexibility — TWICE the height range — of former machines. Add the following all-new advantages and you'll see why we think it's the finest low-coal drill on the market today.

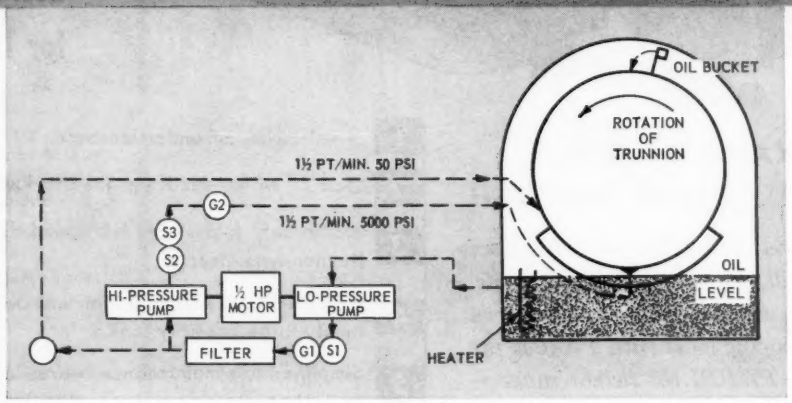
1. 5 full inches of underclearance.
2. Just 7" of lost feed. (½ the previous minimum).
3. Stall-proof, four-wheel full speed-range drive, with traction-type steer.
4. Built-in *internal* dust collection with our new easy-empty large capacity tank.
5. Simplified low-maintenance hydraulic system. *All* controls at operator's position.
6. Over *twice* the traction, *twice* the torque and more thrust than ever before.
7. Can be equipped for rotary impact drilling where required.



Call us for more information on the new model DBE Fletcher LOW Roof Control Drill.

J. H. FLETCHER & CO. | P. O. Box 2143, HUNTINGTON 18, WEST VIRGINIA
JAckson 5-7811





Floating start, ride and stop for big mills

New Lubritrol system provides constant lubrication for trunnion bearings

Volume producers throughout the metallic mining industry are taking advantage of the cost-cutting, space-saving advantages of big grinding mills. When *you* modernize with a bigger mill insist on Allis-Chalmers — the only mill that gives you the positive protection and maintenance economy of *Lubritrol* constant lubrication. These new and bigger mills actually *float on oil*. No bearing-wearing starts. Less wasted horsepower. All functions of the *Lubritrol* system are automatic . . . controlled by foolproof pressure gages and switches.

There's an expert in your nearby A-C office ready and willing to help. Or drop a line to Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

Lubritrol is an Allis-Chalmers trademark. **ALLIS-CHALMERS**

A-5934

When you're talking about a $162,000 dipper shovel, you've got to talk about the best rope for it

Talking about or working with, the same thing applies. Anything below Royal Blue's performance level is simply unrealistic. Like looking for a cut-price brain surgeon.

Even at $162,000, the cost of wire rope is important. That's why so-so ropes can cost you more in the long run, because so-so ropes are *short run*. Royal Blue, on the other hand, is built by America's oldest manufacturer of wire rope to last, to do the job without a whimper. Here's why.

Royal Blue is made from the toughest rope wire ever made—Type 1105—extra high-strength improved plow steel. This pedigree gives to the rope qualities that you can't find in any other rope: exceptional resistance to shock, abrasion, fatigue and impact. Add to these a flexibility that age cannot wither nor hustling fade and you've got a collection of characteristics that make Royal Blue the strongest rope you've ever used.

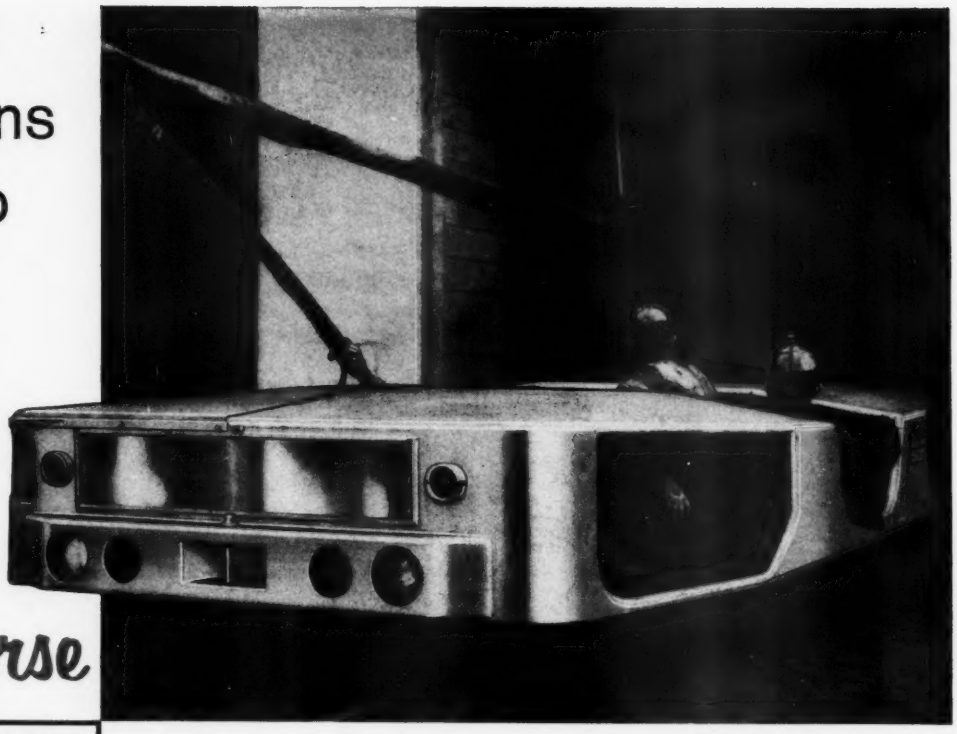
A $162,000 Dipper Shovel deserves the best and your Roebling Distributor has it . . . Royal Blue. For information, write to Roebling's Wire Rope Division, Trenton 2, N. J.

ROEBLING

Branch Offices in Principal Cities

John A. Roebling's Sons Division • The Colorado Fuel and Iron Corporation

Reasons why so many mines use the Lee-Norse LOW mine portal bus



1. FAST—Cuts portal to portal time as much as 50%.
2. STREAMLINED—Transports 11 to 13 men in safety and comfort in low seams.
3. SAFETY—Exclusive split-roof allows operator full directional vision—trolley pole easily reached. Quick acting hydraulic truck-type brakes on each axle and on the traction gearmotor. Independent mechanical hand parking brake each axle.
4. POWERFUL—Self-propelled by sturdy traction-type 15 HP gearmotor (250 or 550V—DC).
5. RUGGED—Quality built to withstand the hard usage of 'round the clock mining!
6. LOW MAINTENANCE—Simple design—easy accessibility.
7. OPTIONAL FEATURE—Electric dynamic brakes for plus safety on severe grades.

LN

Lee-Norse Company

CHARLEROI, PENNSYLVANIA

Specialists in Coal Mining Equipment

All Du Pont permissibles now contain something extra...an extra margin of safety for everyone in the mine.

Ten percent sodium chloride has been added which, according to our interpretation of the U. S. Bureau of Mines data, gives a reduction of at least 50% in the tendency to ignite coal gas. A year and a half of actual underground use has shown that ten percent salt has no effect on the strength, sensitivity, or other explosive properties of the Du Pont Permissibles. But it *does* have a remarkable cooling effect on the flame.

While no permissible used as recommended by the Bureau of Mines has ever been known to cause a coal mine disaster, human error has. What Du Pont has done is to add an extra margin of safety to compensate for those errors which must always be considered as long as men work the mines.

Today, the lives of all those who mine coal beneath the earth's surface are safer and better through continuing research.

For complete information on how Du Pont's High-Salt Permissibles can increase the safety of your men, call your Du Pont representative or write directly to Du Pont, Explosives Department, 6444 Nemours Bldg., Wilmington 98, Delaware.

DU PONT EXPLOSIVES

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

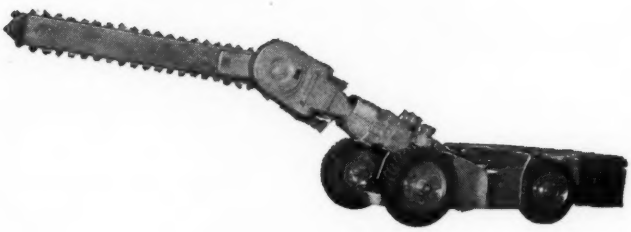
CONTINUOUS IMPROVEMENTS

OVER THE YEARS...

KEEP JOY CUTTERS COMPLETELY MODERN

Rubber tired cutters were introduced by Joy in 1942. Since that time new models have been introduced . . . for high seams, low seams, universal machines. But improvements do not end with the introduction of new machines. A continuous program, which we call "follow-up engineering," has been at work. Field reports, service reports and suggestions by customers are carefully followed up and sifted. Changes and improvements are made. The result is a full line of cutters that is completely modern in every respect . . . as foolproof and rugged as engineering standards can make them. Talk to a Joy engineer about *any* cutting problem you might have . . . he's sure to have the answer.

892

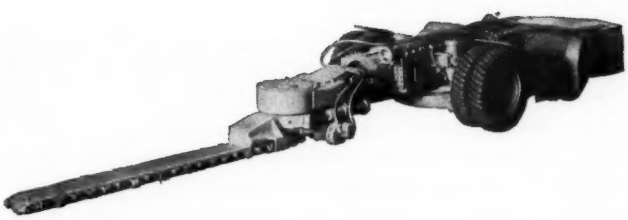


10-RU — Completely universal action to top cut, bottom cut, shear or anything in-between, from 5 in. below floor to 7½ ft. above. Machine height 41".

12-RB — A bottom cutter for seams as low as 30 in. Makes full 30 ft. wide cut. Top cutter model, the 12-RT is also available.

10-RU, 11-RU and 15-RU AVAILABLE WITH FOUR-WHEEL TRACTION

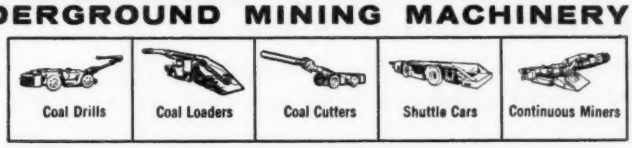
11-RU — A universal cutter only 31 inches high for medium-low coal. Cuts from 10 in. below floor to 64 in. above.



15-RU — A heavy-duty universal cutter for hard, continuous cutting. Especially suited for potash, salt, gypsum and soft limestone.

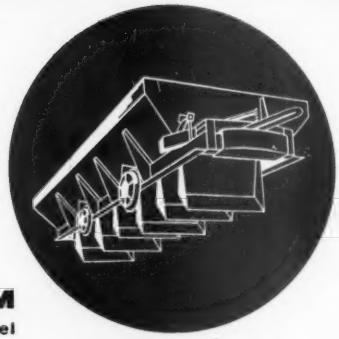
WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY

JOY

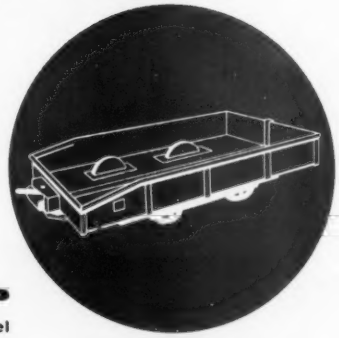


Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

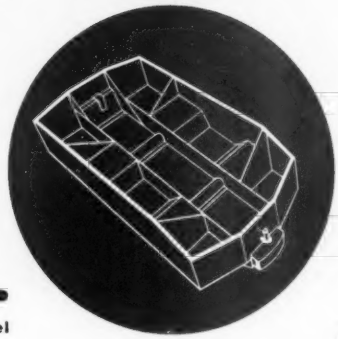
In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario



DROP BOTTOM
4 wheel or 8 wheel



END DUMP
4 wheel



ROTARY DUMP
4 wheel or 8 wheel

acf MAKES ALL THREE

No matter what type of car your mining operations call for acf has a car to fit your needs. acf mine cars are built in all types and sizes from 2 to 30 tons, or more.

For safety, low maintenance and high speed constant haulage all acf mine cars have special features developed through many years of experience in design and manufacture.

Anti-friction bearings in the load-support wheels permit safe high speed from loading point to unloading point and back again for more. Automatic couplers make car handling safer and faster. acf double-action spring bumpers lower maintenance on everything from trackage to locomotive...provide smoother, safer hauling.

For complete information about the full line of acf Constant Haulage Mine Cars in all sizes and types contact the nearest acf sales office or discuss your haulage problems with one of our sales representatives.

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Division of acf Industries, Inc.
750 Third Avenue, N.Y. 17, N.Y.

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EUCLIDS RUSH "Life-Line" TO ORE MINE

Because of its location in a very remote and practically inaccessible area of northern Quebec, a big iron ore mining development awaits completion of a new 200 mile railroad. When operations are in full swing, iron ore from Quebec Cartier's new mine will be transported by rail to Port Cartier, east of Shelter Bay on the St. Lawrence River. From there it will go by ship to steel mills in the United States, Canada and Europe.

Construction of this railroad through rugged country is a big tough job—one that requires dependable, large capacity equipment to keep the rush project on schedule. Pitts-Foley Co., contractors, are using 25 Euclid Rear-Dumps of 22-ton capacity. Powered by diesel engines of 300 h.p., these "Eucs" haul heavy rock excavation from cuts to fill areas. In spite of steep grades, rough roads and an operating schedule of 20 hours 6 days a week, these heavy duty haulers are maintaining an availability record of 90% or better.

With over 25 years of experience in building specialized earthmoving equipment, Euclid and its world wide dealer service organization offers you bonus benefits that bring a greater return on investment. See your Euclid dealer for technical assistance with any off-highway hauling problem.

EUCLID Division of General Motors, Cleveland 17, Ohio

GM GENERAL MOTORS EUCLID

EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE

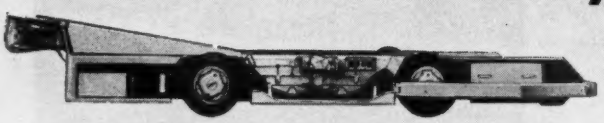
NATIONAL MINE SERVICE COMPANY

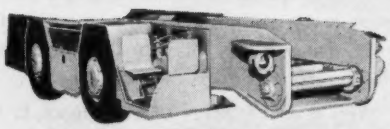
In 1959...the third

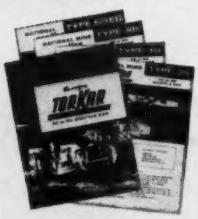
FAR MORE TORKARS

than any other

THE COMPLETE TORKAR LINE







TYPE 26—D.C. or A.C.

Engineered for performance in thinnest commercially-workable seams—overall body height only 25½". Capacities from 120 to 167 cubic feet.

TYPE 30—D.C. or A.C.

With heights from 30" to 36"—ideally suited to low seam work. Capacities 120 to 167 cubic feet in standard units. *Wide Car* models have up to 24" additional width, with capacity increased accordingly.

TYPE 48—D.C. or A.C.

With heights from 40" to 54"—Type 48 offers capacities from 155 to 290 cubic feet in standard units. *Wide Car* models have increased capacity through addition of up to 24" extra width.

TYPE 60—A.C., D.C. or Diesel

Now available in new electrically-powered models, this is the largest and most powerful TorKar type. Capacities: Type 60 A.C. or D.C., 375 to 455 cubic feet; Type 60 ED Diesel (for non-coal mining), 295 cubic feet.

WRITE

for technical bulletins and specification pages on TorKars

announces with pride

year of manufacture...

SOLD to the mining industry make of shuttle car

Essential reasons behind this Trend to TorKars: **lowest cost per ton of material handled—with dramatic records of performance and low maintenance wherever they are used.**

TorKars are unique in that they are powered by a single, large-capacity motor in place of small multi-motors required on conventional shuttle cars.

With a torque converter and three-speed forward-and-reverse transmission applying power equally to all four wheels, flexibility of operation is greatly increased, the control system is simplified, service costs are lowered, and high operational standards are maintained. • ***May we discuss TorKar performance with you?***

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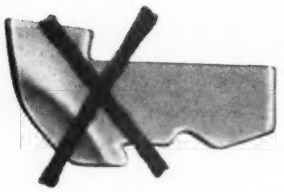
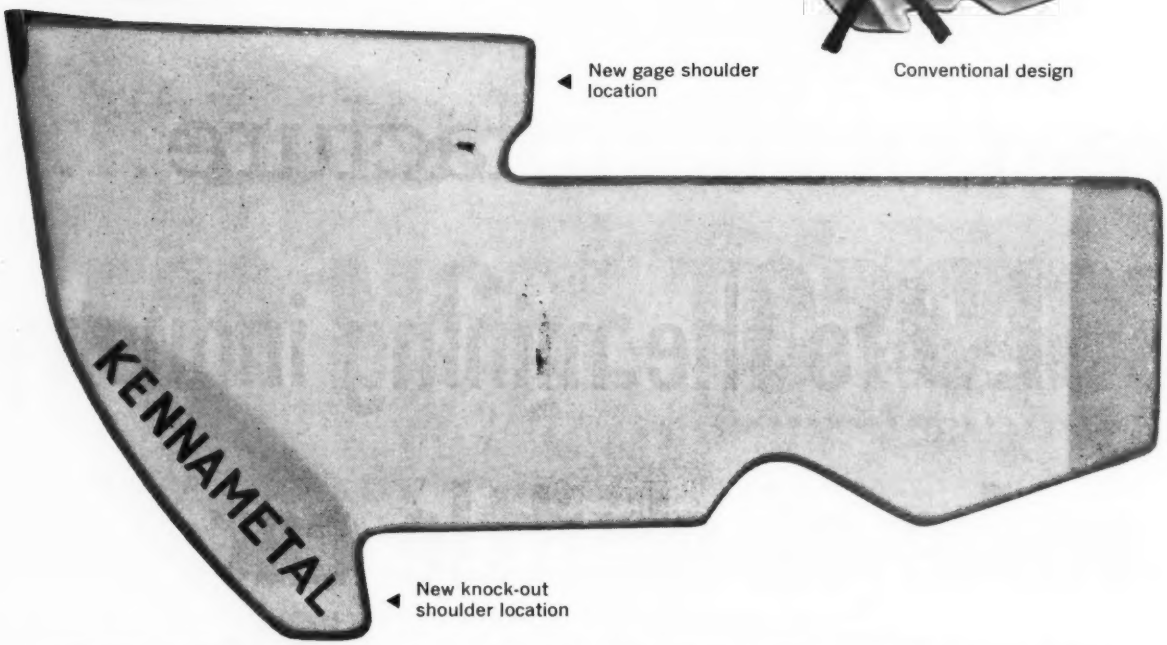
THE DIFFERENCE SHOWS UP IN PERFORMANCE



Conventional design



KENNAMETAL U17 SERIES CUTTER BITS

with new gage shoulder location . . . another step toward smoother production

Better Seating

- New positioning of the gage shoulder gives greater tool rigidity. The rubber keeper is subjected to much less flexing than in other designs . . . keepers last longer.
- "Pounding" that causes wear and distortion of bit blocks is minimized.
- Held firmly against the work, the U17 gives more positive cutting action. Reduced strain on the shank protects the carbide cutting tip.

Stronger Design

- Greater minimum-cross-section through head of the bit provides greater strength than other designs.

Easier to Change

- New positioning of the knock-out shoulder provides better leverage for bit removal. Bits come out easier, faster . . . saves you time, money.

97274

The new U17 Series Cutter Bit is available in all three standard tip styles. Ordering designations are: U17—Full Nose Radius (open face) Carbide Tip . . . U17R—Recessed Tip . . . U17RA—Cylindrical Plug (illustrated above).

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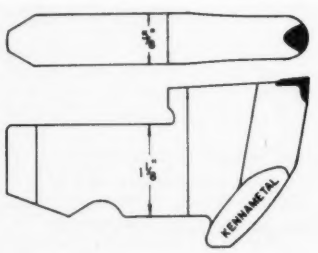

INDUSTRY AND KENNAMETAL
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EDITORIAL

[Editor's Note] *The following guest editorial tells an encouraging story of progress, and looks hopefully to the future. Although it deals with coal mining, its objectives apply equally to all mineral fields. We commend it to metal miners and industrial minerals producers as well as to coal men.*

Progress in Coal-Mine Safety

By MARLINC J. ANKENY
Director, Bureau of Mines
U. S. Department of the Interior

The hazardous nature of coal mining creates much interest, at the close of each year, by those concerned with the human aspects of the "price" in human lives exacted by the industry.

Preliminary statistics on fatalities, assembled by the Bureau of Mines for 1959, show that 290 men were killed in the Nation's coal mines. This is still much too high a price in human life for the industry to pay for its production. By comparison with other years, however, there is a note of encouragement. The 290 lives lost represented the lowest total of any year since the coal-mining industry has been completely covered statistically.

The Bureau of Mines was established in 1910. During the first decade of its existence, the average annual death toll for bituminous-coal, lignite, and anthracite mines was over 2500 men. It was not until 1946 that the annual toll fell below 1000; in that year 968 were killed. In 1953 the toll was 461, the first year under 500; and 1954, when 396 lost their lives, was the first year the toll was under 400. The industry can hardly boast over the fact that only 290 were killed in 1959. But the record gives encouragement of maintaining the downward trend in occupational deaths, because 1959 was the first year the industry "broke" 300.

What of the future? The next "plateau" is 200. How long it will take to break 200 will depend on how hard those identified with coal mining in the United States work to attain it. One thing is certain, as the fatal-injury curve flattens, the more difficult it will become to establish a new, lower record.

The greatest killers of mine workers are falls of roof, face, and rib. The 1960 National campaign to reduce injuries at least 50 percent from these causes is being conducted by the National Safety Council in cooperation with numerous safety-minded agencies, including the American Mining Congress. This is a worthy undertaking in which every coal-mine operation—management and labor—should participate and wholeheartedly support. If successful, the number of coal-mine fatalities for 1960 will be approximately 25 percent less than 1959 because over the years roof falls have caused at least 50 percent of the underground fatalities. The spirit of safety mindedness about roof falls should stimulate a general awareness to other coal-mine hazards and a decline in the death rate from all causes could be expected all along the line.

This is not a "figment of the imagination." During the first five years of the Bureau's existence more men were killed annually in explosions alone than are now killed from all causes. Who would have predicted in 1910 that in 50 years the coal-mine death toll would be reduced over seven-eighths? Further reduction in the years ahead is by no means unattainable but it will be much harder to achieve. It will depend upon how earnestly the industry—workers and officials alike—want to attain further reduction.

Digging Talent Out of High Schools

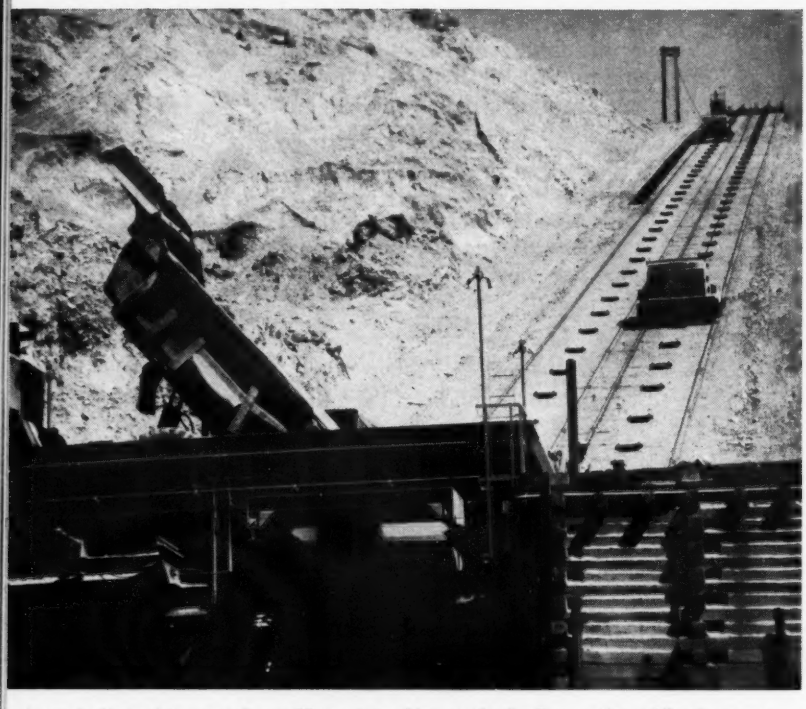
Moves to attract promising high school students into college courses in mineral engineering have been making significant progress in recent months. The success of the "Engineers for Tomorrow" program of the Western Pennsylvania Section, WAAIME, is a real credit to the ladies who initiated and nurtured it along into a fully developed reality (MCJ, November 1959, page 86).

The College of Mines of the University of Idaho recently circulated a letter to the Idaho mineral industry soliciting help in attracting more and better high school students into college training for careers in mining, and offering to send members of the College teaching staff to high schools throughout the state to speak to students, PTA groups, and teachers. The letter stresses the need for contacting students in the early years of high school—while they still have time to work in the college entrance requirements needed to undertake professional training.

Colorado School of Mines will conduct, starting next summer, a six-weeks institute in chemistry and geology for high school students. The program will be supported by a grant from the National Science Foundation. The immediate objective is to provide an opportunity for secondary school students with unusual ability and interest to study chemistry and geology at a level beyond the normal scope of high school teaching. Certainly this activity will effectively point up the opportunities in mining, and will inspire many to pursue further study in the mineral sciences.

Still another move in the right direction is the AIME grant "to bring a select group of high school teachers into the Science Honors Program which Columbia University's School of Engineering has been offering to gifted high school students."

Collectively, these and other similar activities show that a long needed movement is finally getting under way. For years mineral professions and the mining industry have recognized the need for such programs and have exchanged a lot of words about it. Now we're beginning to see a little action, but many more programs to attract capable high school youngsters into scientific careers—particularly in mining—will have to be initiated before industry-wide results become apparent.



A truck dumps into one of two 25-ton surge bins at the loading station while the empty skip is returning to the station

Skip Hoisting

AT THE LIBERTY PIT

By FRANK QUILICI
Pit Superintendent
Nevada Mines Division
Kennecott Copper Corp.

Detailed studies indicated that, as the pit became deeper, conversion from rail haulage to a combination truck-skip hoist system would contribute substantially to increased production and lowered costs

AT Kennecott Copper Corporation's Nevada Mines Division, Liberty Pit, Ruth, Nev., 70,000 tons of ore and waste are produced daily, on a three-shift per day, seven days per week operation.

Prior to 1956 all material was moved from the Liberty pit via rail haulage, but the need for a change from this type of haulage was apparent as the pit expanded and deeper ore was mined. The necessity for very flat slopes in some sections of the pit indicated that the stripping ratio would increase to a prohibitive figure if rail haulage were continued. Bench excavation costs, track maintenance costs and rising operating costs contributed to higher total mining costs as the rail haul distance in the pit increased. Lengthening of haul distances resulted in lower productivity at a time when total production was being increased.

It was determined after detailed studies that a truck haulage-skip hoisting system would be best suited for the Liberty pit operation, and would contribute to increased production and reduced mining costs. Trucks had been purchased in 1955 and 1956 for extensive stripping of overburden at the neighboring Veteran pit. When the ore was reached at the Veteran pit in 1957, a portion of this truck fleet was available for Liberty pit operations.

Transition to New System

During 1957 and 1958 a transition was made from rail to truck haulage in order that the pit could be expanded and preparations could be made for the skip system track way. During that period, truck haul roads approached a distance of two miles from the lowest loading point to the pit perimeter, with an average grade of seven percent. In the meantime haulage costs increased rapidly, and, from this experience it was evident that the decision to construct a skip system was sound.

Construction of the skip system was started in May, 1958, and the system was in operation in June, 1959. During construction approximately 500,000 tons of material was excavated for the track way.

After a tentative location for the skip hoisting system was made, midway on the north side and on the final slope of the pit, slope stability tests of the area were conducted. After these tests were made, it was decided that a pit slope of 23° in the area of the skip system would be required to minimize any ground movement and to best fit the existing ground conditions.

Excavation for the skip slope (19° 04′) was performed with shovels, haulage trucks and bulldozers. The first 200 ft from the top was exca-

vated with shovels and haulage trucks; the remaining distance was ramped down with bulldozers, with material being removed from the bottom of the cut with shovels and haulage trucks. Blast-hole drilling for the skip way was accomplished with a crawler-mounted Drillmaster drill.

The skip system (See figure 1) is 1215 ft long with a vertical rise of 405 ft to the top of the headframe. The skip loading station is located on the 6704 level of the pit with provisions made to install a second loading structure on a lower level, yet to be determined.

Drive-Over Skip Loading Station

A double-drum hoisting system with 25-ton skips to match available 22-ton haulage trucks was selected. The double-drum system will allow additional loading stations to be installed and to be operated at the same time as the mining operations become deeper.

The skip loading structure is of the drive-over type, with two 25-ton surge bins. The skip loading operator opens one of two hydraulically operated bridge gates and a truck dumps directly into a surge bin. The operator then opens one of the two hydraulically operated unloading gates, which loads the skip. This function is semi-automatic in that the skip tender pulls hydraulic levers to operate the bridge gates and unloading gates, and pushes buttons to initiate the automatic hoisting and dumping cycle. Two skips operate in counterbalance.

The drive-over structure and one skip capacity surge bins were selected in order to maintain continuity of mining operations and minimize skip damage inherent with direct loading. This allows a truck to dump without waiting for the skip or for the skip to load without waiting for a truck during short delays in operations.

Two 25-ton capacity skips, in counterbalance, hoist ore from the loading station to the storage bin for transfer to railway cars

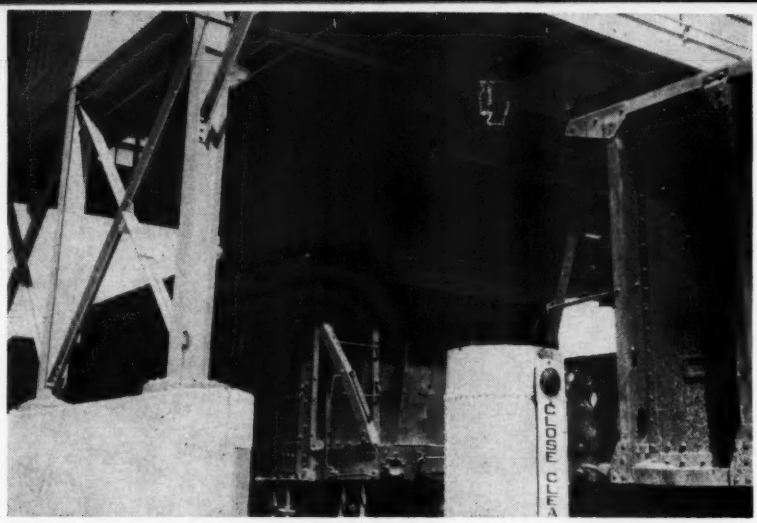
The skip railway consists of a double set of 90-lb rails with 10 ft 5 in. gauge on 14 ft 2 in. centers. Converging slightly at the base of the headframe, the tracks continue up the headframe to permit dumping into the storage bins. The track is laid on 14 ft ties placed on 2½ ft centers, with each fourth tie 18 ft long. All ties are ballasted and secured with pins driven into the ground. Non-slip tie plates were placed between the rail and ties. Rubber-lined rollers were placed on 25 ft centers to support the cable. A walkway was constructed along the skip track to aid personnel inspecting the track and rollers.

FIG. 1. SKIP HOISTING DATA

Elevation loading station (top)	**6,704 ft**
Elevation headframe (base)	**7,033 ft**
Total hoisting distance	**1,215 ft**
Slope of skip track way	**19° 04′**
Total vertical rise	**405 ft**
Weight	
Ore (wet)	**50,000 lbs**
Skip	**39,490 lbs**
Rope	**5.6 lbs/ft**
Rope diameter	**1⅞ in.**
Feeder and gate widths	**7 ft**
HOIST	
Drum diameter	**11 ft 0 in.**
Type—Double cylindrical drum clutched	
Drive—Twin pinion; four 300-hp, 1,150 rpm motors in a single series loop with two 500-kw generators, driven by one 1,250-hp leading power factor synchronous motor	
Rope speed	**1,630 fpm**
Acceleration time	**12 sec**
Retarding time	**10 sec**
Rest time	**7 sec**
Total cycle time	**63 sec**
Maximum capacity (based on 47 min operating hr)	**1,120 wet tph**

Skip Wheels are Spring-Mounted

The 25-ton skip operates like a Kimberly type skip, except that the body rests on a four-wheel open frame chassis. To provide cushioning, the wheels are spring-mounted and the rear axle will pivot, resulting in three point suspension. This allows the skip to travel at high speed without danger of derailment. The body is of double-wall welded construction in order to reduce weight, increase strength and to provide the shock absorbing qualities required for loading. It is suspended within the skip



Two parallel reciprocating feeders with openings seven ft wide supply ore from a surge bin to a railway car at a maximum rate of 80 tpm

chassis by means of trunnions at approximately the center of gravity of the load so that the dumping of the skip is a rocking action of the body within the chassis. The skips are dumped by means of scrolls on dump plates mounted on the headframe above the storage bins. The automatic slow down control is set so that the skip enters the scrolls at a speed of 190 fpm with the hoist pulling the skip through the scroll to rotate the body, dump the load and stop.

The skip headframe contains two storage bins, which have a level capacity of 100 tons and a surcharge capacity of 180 tons, and four 7-ft reciprocating plate feeders. The skips dump directly into the storage bins, which are separated by hydraulically operated flop gates so the skip loads may be directed into either bin at will by the operator. This facilitates the loading and separation of ore and waste. Two hydraulically operated reciprocating feeders service each bin and feed railway cars or trucks. Two feeders can load one 80-ton railroad car in approximately one minute. Two parallel railroad tracks go under the headframe. Railroad cars or trucks will be loaded from either bin.

The car feeder operator controls the bin flop gates, reciprocating feeders and feeder dribble gates via semiautomatic push button control.

Double Drum Hoist Has D-C Drive

Communications between the car feeder operator and the skip loading operator are maintained by means of a paging system (squawk box) and telephone. Communications between the car feeder operator and the railroad crews are by two-way radio and a hand and light signal system.

The hoist proper is a double drum cylindrical unit with the two drums coupled by an expanding toggle type clutch. The drums are 11 ft in diameter and eight ft wide; they are grooved for 1⅞ in. rope. Each drum has its respective mounted bullgear, and each bullgear is powered by twin and individually motor driven pinions (the ratio being approximately 24: 1). The drive is a variable voltage d-c system employing four 300-hp motors in a single series loop with two 500-kw generators. The two generators are driven by a single 1250 hp leading power factor synchronous motor. This motor receives power from one of four secondary feeders at the Liberty pit 2500 kva 2300 v substation.

Braking is accomplished by electrical regenerative braking and positive mechanical brakes. Mechanical braking is accomplished by means of four spring set brake shoes, one mounted on each motor coupling. These mechanical brakes afford 4000-ft-lb of torque each and are applied through solenoids when the hoist is decelerated to approximately five percent of speed.

Semiautomatic Hoisting Cycle

One of the main features of the skip system is its semiautomatic control. The skip loading operator controls the movement and dumping of haulage trucks at the loading station by means of signal lights, and the loading, hoisting, and automatic dumping of the skips by means of push button controls.

The car feeder operator at the headframe controls the storage bin flop gates, reciprocating feeders, and feeder dribble gates by means of push button controls.

Currently seven 22-ton haulage trucks feed the skip system from two 4-yd electric shovels. The ore is loaded into railroad cars for shipment to the reduction plant at McGill. Waste is loaded in 35 and 40-ton haulage trucks at the headframe and is transported to dumps. The major part of the remaining waste from the upper levels of the pit will be loaded directly into haulage trucks and hauled to dumps. The upper level ore will also be trucked to railway cars. Operating costs will dictate the elevation of the direct truck haul-skip haul cut-off point.

The skip system was installed to handle an average of 7000 tons of waste or ore a shift. Hourly and shift capacities were reached almost immediately after start-up early last fall, with operating sequences following the planned pattern. It is felt that skip performance will meet designed performance when the test and break-in period has been completed. Truck maintenance and operating costs in the 22-ton class have been greatly reduced and the fleet required to move ore from the lower levels of the Liberty pit has been reduced by more than 50 per cent.

Advantages of System Enumerated

Advantages of the skip system include: (1) greatly reduced stripping ratio required for pit expansion over conventional haulage methods in that limited access and service roads only are required in reaching ultimate pit limits, (2) elimination of the necessity of maintaining benches for railroad tracks or haulage roads, (3) flexibility in planning the mining sequence, (4) lower pit equipment capital and maintenance costs, (5) minimizing ore car maintenance on the mine-reduction plant rail haul due to decreased loading damage as well as an improved load factor, and (6) increased productivity.

Many of the improved features resulting from the operating experience of a similar skip-hoist at the Pima mine near Tucson, Ariz., were incorporated in the Liberty pit installation.

Construction of the skip headframe, hoist house and skip loading structure was performed by the prime contractor, National Iron Co. of Duluth, Minn. Construction of the skip track way and necessary cribbing for the approach to the skip loading structure as well as the service roads and track to the headframe was performed by company personnel.

Pillaring Operations with Continuous Mining Machines Under Bumping Conditions*

By WILLIAM NORRIS, JR.
Safety Director
Olga Coal Co.

Olga Coal Co. has not solved all of the problems connected with bumping, but its experiments are certainly a step toward a final solution of mining pillars with continuous mining machines under definitely known bumping conditions

OLGA Coal Co. operates two mines in the Pocahontas No. 4 seam in the extreme southern portion of West Virginia. The two operations, one located at Coalwood and the other at Caretta, have a combined production of approximately 8500 tpd. The mines are connected and the coal from both mines is processed at a central preparation plant located at Caretta. Both are shaft operations with 580-ft deep vertical shafts. The terrain is mountainous and the depth of cover over the Pocahontas No. 4 seam varies from about 600 ft in the valleys to approximately 1600 ft under the highest ridges.

The seam varies in thickness from about five ft to more than eight ft, averaging about 6½ ft. The coal is soft and friable and the ribs tend to crush and spall off under the pressure of the overburden. The bottom may be classified as a hard fireclay which is not affected by water but which in some areas will break, even in advance workings, and may heave badly during pillaring operations. The main roof is generally a hard massive sandstone but in some areas it is replaced by a laminated sandstone with thin coal partings which is difficult to support. Over most of the property the immediate roof above the coal is shale, known locally as draw slate, ranging from several inches to two ft in thickness, although in limited areas it may increase in thickness to five or six ft. This shale is weak and must be supported immediately after exposure either by conventional wood crossbars or by roof bolts.

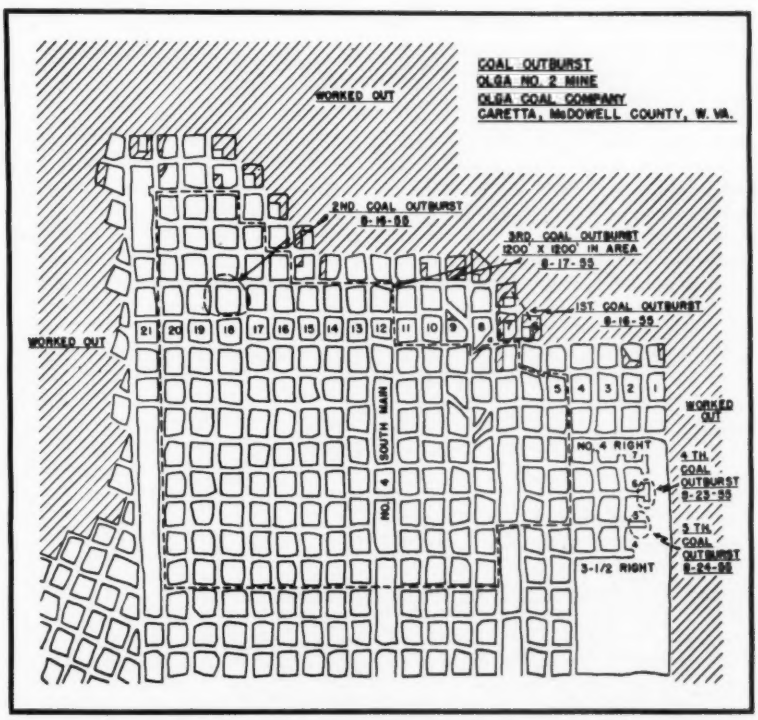


Fig. 1. In extracting chain and barrier pillars, which had been left between previously robbed out areas, Olga Coal Co. soon found that any irregular or oversize blocks ahead of the pillar line were potentially dangerous and subject to bumping. However, by splitting these oversize blocks well in advance of the pillar line, the company was able to avoid trouble in most cases. Locations of some of the bumps that occurred are shown

* *Presented at the 47th Annual National Safety Congress.*

Block System Employed

Coal is mined by the block system, all entries and rooms being driven on 75 by 90-ft centers with complete extraction of the pillars. All places are driven 18 ft wide, leaving blocks of coal 57 by 72 ft for final mining. Roof bolts set on four-ft centers in both directions and within 30 in. of the face are used to support the roof in advancing entries and rooms. In some locations timbering in addition to roof bolting is necessary to support weak roof. Where continuous mining machines are used the place is advanced a breakthrough length with conventional timbering. The machine is then moved to another place, the roof bolters move in and bolt the roof and the conventional timbers are removed for reuse.

Pillars are extracted by means of 18-ft wide open end lifts. In conventional mining both sides of the block are worked simultaneously, but in continuous mining alternate lifts are taken from the right and left sides. Timbering in pillar work consists of two rows of timbers on the open side of the lift, on maximum centers of four ft with crossbars on four-ft centers where needed. Wood cribs are also used where considered necessary both for additional support on the pillar lifts and at the intersections.

The Pocahontas No. 4 seam in this locality is very gassy, methane being liberated freely from the faces and ribs during development work. During the extraction of pillars the falls extend upward into an overlying seam known as the Pocahontas No. 4 rider seam and large volumes of methane are released, particularly when fresh falls occur. These factors influenced the early layout of the mines with multiple entries being driven for maximum air flow, the provision for separate bleeder airways and a large number of working places to permit single shift operation of the faces to reduce the rate of methane liberation.

Main entries were driven in sets of 8 to 12 with room entries in sets of two turned off at right angles approximately 700 ft apart and extended to a depth of 1800 to 2200 ft. From these room entries, rooms were turned on 75 or 90-ft centers, according to the direction of driving, and the extraction of the pillars on the advance was started immediately. With adequate barrier pillars left for protection the main entries were extended to the property line, additional room entries were turned and developed and pillaring continued until the property line was reached. Thus the robbed out area would be 1500 to 1800 ft across and a mile or so long. The pillar line was pulled on approximately a 45° angle and at full extent was around 2000 ft long. With hand-loading and later with track-mounted machines it was possible to maintain a fairly straight pillar line by shifting men or adjusting the territory allotted to a machine. A high percentage of recovery was obtained and bumps were practically unknown.

Factors Believed Responsible for Bumps Include Heavy Cover

However, trouble arose when the company began to extract the chain and barrier pillars which had been left between previously robbed out areas. It was soon found that any irregular or oversize blocks ahead of the pillar line were potentially dangerous and subject to bumping. Many of these irregular blocks were present in the form of long seal pillars between main intake and main return airways which had been left to reduce the number of stoppings required to conduct the ventilation to the face areas. By splitting these oversize blocks well in advance of the pillar line, the company was able to avoid trouble in most cases but in some areas this did not entirely solve the problem. The following factors are probably partly responsible for the tendency for bumps to occur in a given area:

1. **Heavy cover under the higher mountains.**
2. **Rapid change from heavy to moderate cover between the mountains and the valleys. This may set up horizontal stresses in the strata.**
3. **The presence of numerous faulted or want areas which may or may not have prestressed the strata before mining is begun or which may interfere with the orderly settlement of the strata as mining progresses.**
4. **Massive layers of sandstone in the overburden which prevent a complete break after the first pillar mining and severely overload the remaining pillars left for the final retreat.**
5. **Soft friable coal which tends to crush and permits bending of the strata rather than breaking.**
6. **Large mined out areas with no complete break to the surface.**

A typical example of the above described conditions is the No. 4 South Main section at Olga No. 2 mine which had a history of bumping over a four-year period. Large areas had been previously mined out on both sides of No. 4 South Main. A fault

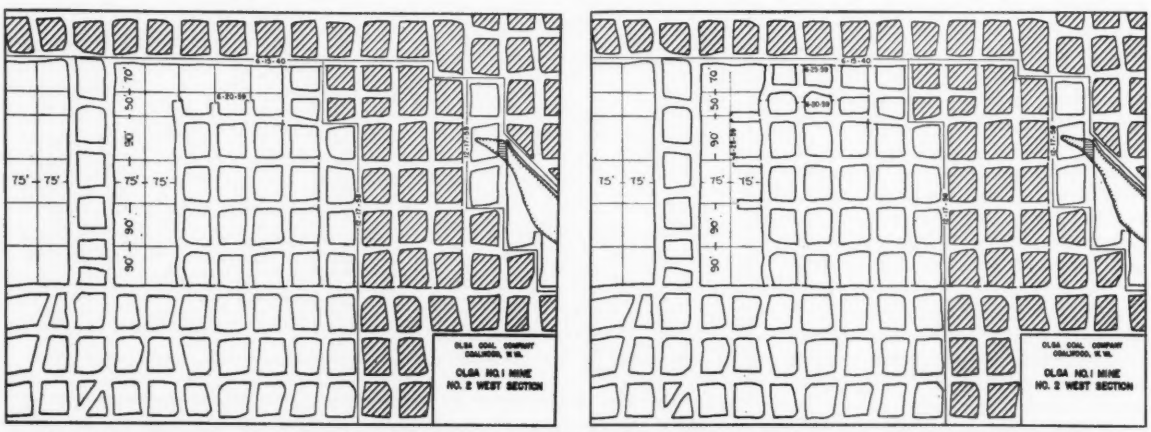


Fig. 2 & 3. The present method (left) of developing and extracting barrier pillar blocks with a ripper-type continuous mining machine is to drive three rooms on 75-ft centers into the end of the block next to the pillared area. The solid coal left in the block tends to absorb the stress and minimize bumping. With the completion of these three rooms, breakthroughs (right) are turned off No. 1 room, into the solid coal, and the rest of the block is developed driving away from the pillared area. Method of extracting the individual 75 by 90-ft blocks is by open-end lifts

was encountered near the property line. When final mining had extended approximately 1000 ft from the fault, a violent bump occurred in an oversized block which was being split too close to the pillar line. This bump resulted in the death of two men and serious injury to a third and broke the loading machine into three parts. Bumps then occurred intermittently as lighter cover was encountered but later, again under heavy cover, bumps became an almost daily occurrence. Care was taken to split the blocks well ahead of the pillar line to a uniform 75 by 90-ft size. The bumps usually occurred three to five blocks outby the pillar line and there was no indication as to which block or which area of the pillar line would bump next. In one bump practically every block in an area more than 1000 ft sq bumped and an entire row of brick stoppings was ripped out.

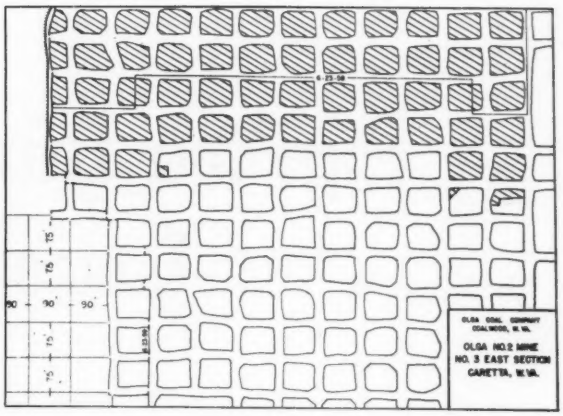


Fig. 4. Flat pillar line method of extracting pillars where a single line of blocks is mined out flat

Block Is Developed Driving Away from Pillared Area

With the advent of continuous mining and with the knowledge that there are large areas of coal to be pillared out between previously robbed out areas, an attempt has been made to adapt the system of mining pillars to these conditions. Olga does not feel that it has solved all of the problems connected with bumping nor has it been able to entirely prevent bumping. Instead, the company considers the method as an experiment and, it is hoped, a step toward a final solution of mining pillars with continuous mining machines under definitely known bumping conditions.

No. 2 West Section at Olga No. 1 mine is typical of the conditions previously described. Originally developed as a ten-entry system with entries on 90-ft centers and with 450-ft thick barrier pillars on both sides, the adjoining areas on both sides had been pillared out some 15 to 20 years ago. Retreat mining was started in a faulted area. An area mined out between two faults was probably not large enough to be conducive to bumping, at least no bumps occurred. Now the mining is away from the faulted area and some bumps have occurred, although not very violent and fortunately without personal injuries.

The present method of developing and extracting the barrier pillar blocks with a ripper-type continuous mining machine is to drive three rooms on 75-ft centers into the end of the block next to the pillared area. The solid coal left in the block tends to absorb the stress and minimize bumping. However, some bumping has occurred, the critical point being reached just before the rooms cut through into the robbed out area. With the completion of these three rooms, breakthroughs are turned off No. 1 room, into the solid coal, and the rest of the block is developed driving away from the pillared area.

After the entire block has been cut up into 75 by 90-ft blocks, pillaring is started in the innermost corner of the block, three blocks in a line. The method of extracting the individual blocks is by open end lifts as previously mentioned. Eighteen-ft wide lifts are taken from alternate sides of the block until only a small stump is left which is pushed out from the outby side. This is the same method of recovery as was practiced in the past as far as the individual block is concerned. The principle change from previously used systems is in developing the large block just ahead of the pillar line and insofar as possible, driving rooms and breakthroughs into this block in a direction away from the pillared area. The company feels, and has hope, that when so developed the large block tends to act as a buffer block which if it does not entirely prevent bumps will lessen their severity.

Flat-Line Method is Used in Non-Bumping Areas

Another method of extracting pillars which the company uses in so-called non-bumping areas is the flat line where, instead of extracting pillars in a three-block line, only a single line of blocks is mined out flat. The area shown in figure 4 had been developed many years ago by driving eight entries into the area from Olga No. 1 mine. These entries are badly caved and when the territory was assigned to Olga No. 2 mine, four additional entries were driven parallel to the original eight entries and a set of chain pillars left from the original development extracted. The present area being mined is between the original eight entries to the right and a fault on the left and is about 1000 ft wide. Short rooms are driven into the coal to the fault on the left side. Then the continuous mining machine takes out No. 11 pillar on the left, then No. 10, No. 9, etc. At the same time another continuous mining machine is taking out No. 1, No. 2, and No. 3 pillar, etc. on the same flat line. As the machines approach each other until only two blocks are left, one machine moves over to start another line of blocks while the other extracts the two remaining blocks, right and left, off the same runway.

In using the term "so called non-bumping areas," the writer had in mind that this area is not being mined between previously mined out areas as described in the early part of this article. However, light bumps do occur, sometimes every few minutes, and while they seldom dislodge coal from the ribs, they do jar the area considerably and give one a rather uncomfortable feeling. These bumps are much harder and may throw some coal if the continuous mining machine is advanced into the coal next to the solid rib. If the side of the face next to the gob is kept ahead, the bumping is less severe. The operators of the continuous mining machines have learned that by tickling the hard coal next to the solid rib a bump can be induced which will loosen up the face and make loading easier, and they often do just that.

Olga Coal Co. has not solved the problem of bumps, but if it has added something to the sum total of knowledge of this important subject, management will be satisfied.

Pipeline Transportation of Concentrates

Erection of a system for pumping 1800 tpd of concentrates 7½ miles was the result of elaborate test work to determine correct pipe size, pumping station spacing and power requirements

By D. A. FRASER
Assistant Manager
Reduction Plants
International Nickel Company of Canada, Ltd.

THE Creighton mill of International Nickel Company of Canada, Ltd., is located at the site of the Creighton mine No. 7 shaft, approximately six miles west of the company's reduction plants at Copper Cliff, Ont. The mill treats 12,000 tpd of ore from which 1800 tpd of copper-nickel sulphide concentrate is recovered by flotation. The concentrate is pumped a pipeline distance of 7½ miles to the Copper Cliff concentrator for further processing.

When the decision was made to build the Creighton concentrator, the logical area to use for disposal of tailing from the new mill was the Copper Cliff mill tailing disposal area, four miles distant, located between Creighton and Copper Cliff. Since this would necessitate the building of new trestle and pumping stations to connect the two mill tailing disposal systems, the feasibility of pumping bulk concentrate from Creighton to Copper Cliff was investigated.

Test Work

The purpose of the test work was to determine the size of pipe, spacing of pumping stations and power require-

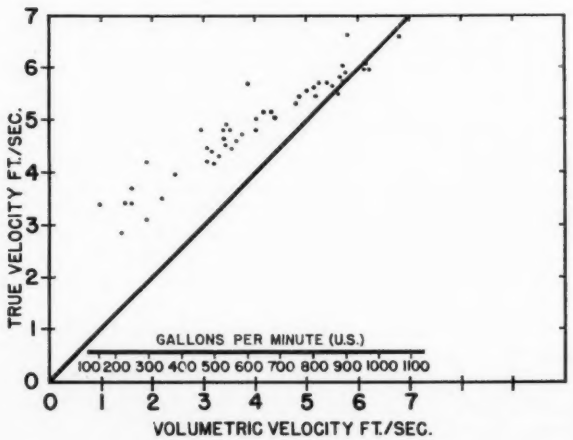


Fig. 1. Relationship between true velocity and volumetric velocity in an eight-in. test line

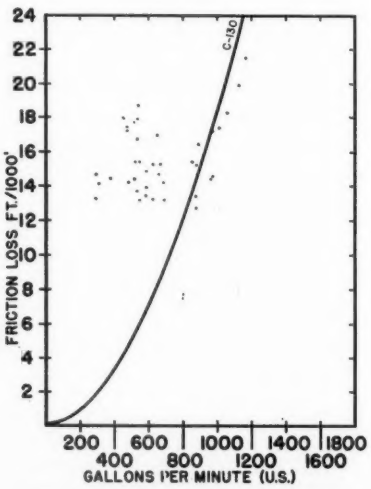


Fig. 2. Relationship between friction loss and rate of flow in an eight-in. test line

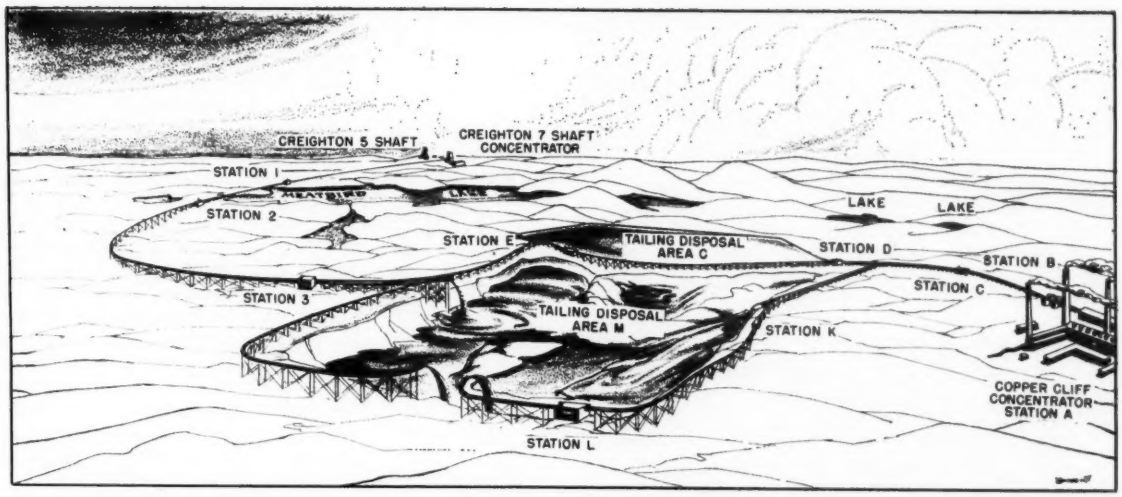


Fig. 3. Artist's drawing of the completed pumping system between the Creighton and Copper Cliff mills

ments. The problem was to find the size of pipe which would give the lowest friction loss for the volume of pulp to be pumped and thus keep power consumption and wear on the pipe to a minimum. Low friction loss is associated with low velocities, but the limiting factor is the critical velocity or lowest velocity which will maintain the material in the pipeline in motion. The objective, therefore, was to determine this critical velocity for design purposes.

The initial test setup in the Copper Cliff mill consisted of a straight horizontal run of 400 ft of four-in. standard steel pipe through which nickel concentrate and water, in any proportions, could be pumped. The test work on this four-in. pipeline led to the conclusion that eight-in. pipe would be required for the proposed Creighton to Copper Cliff pipeline.

To check this conclusion a temporary test line was erected. It consisted of 4000 ft of eight-in. wood stave pipe, following a profile with a more or less uniform rise from a pump to a high point 2000 ft distant at an elevation 59 ft higher than the center line of the pump, and returning along the same profile to a measuring sump located near the pump. The pump was a Canadian Allis-Chalmers 8-in. by 6-in. SRL–C, by means of which concentrate and water in any desired proportion could be pumped through the line. Pressure gauges were mounted at each end of the line and at the high point. A pH meter near the end of the line and a graphic wattmeter on the motor input completed the essentials of the test circuit.

The test work on both of the above lines consisted essentially of determining pressure loss due to friction and pipeline velocities for different rates of flow and at different pulp densities ranging from water up to 45 percent solids, by weight. Pipeline velocity was obtained by dumping a pail of lime slurry into the pump intake and measuring the elapsed time for the lime to reach the pH meter near the end of the pipeline. The velocity so obtained was called "true velocity" and the velocity obtained by dividing rate of flow by the cross sectional area of the pipe was called "volumetric velocity."

Critical Velocity

Figure 1 shows the relationship between true velocity and volumetric velocity in the eight-in. test line. The dots represent the test points and the solid line represents the theoretical locus of equal velocities. True velocity tends to be higher than volumetric velocity due to the accumulation of settled solids in the bottom of the pipe. Varying the pulp density between 10 percent and 45 percent solids made no discernible difference in this relationship, so that all test points between these density limits were included on the graph. Every plotted point on the graph represents the average of at least two, and in most cases three, sets of determinations. It will be observed that the two velocities approach each other with increasing values and tend to become equal at about six fps, which is established as the critical velocity for the concentrate in this density range.

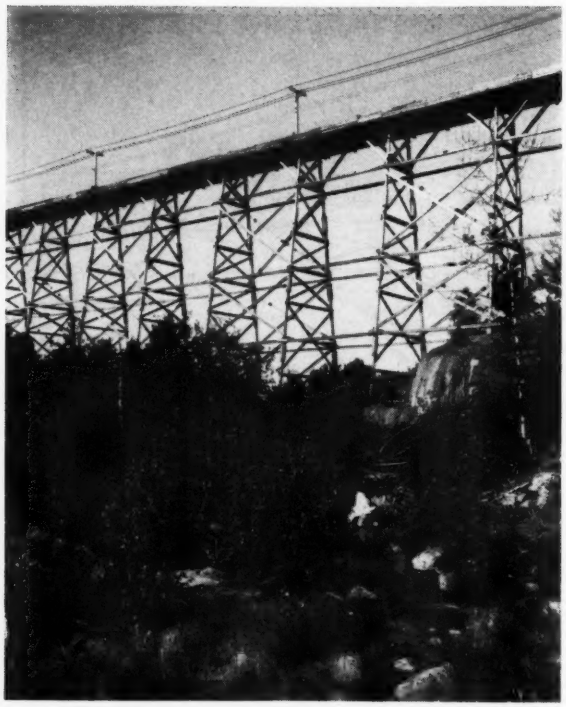
This critical velocity is the velocity required to prevent solids settling and accumulating as a layer in the bottom of the pipe. It is not the same as the more usual meaning of critical velocity, that velocity at which streamline flow changes to turbulent flow, as used in text books on hydraulics.

Friction Loss

Figure 2 shows the friction loss in the eight-in. test line, expressed as loss of head in feet of material pumped per 1000 ft of pipe, plotted against rate of flow in U.S. gpm. Within the range of 10 percent to 45 percent solids, pulp density appeared to have no effect on the relationship, so that all tests within these density limits are included on the graph. The solid curve represents the friction loss for water in an eight-in. wood stave pipe as given by the Williams and Hazen formula with C equal to 130, where "C" is the roughness factor of the inside of the pipe. Based on this test data and on information obtained from other pipeline installations it has been concluded that the friction loss tables for water as based on the Williams and Hazen formula are applicable to pulp as long as it is considered that the tables express head loss in feet of pulp and as long as velocities in the pipeline are above the critical velocity.

For design purposes a more conservative view is taken of the roughness factor and C equal to 120 is used for wood stave pipe and C equal to 100 for steel pipe.

The test work on the eight-in. line pointed out another factor which would be of considerable importance in designing a line over hilly terrain. It was found that the friction loss was greater on the uphill section of the line than it was on the downhill. The results plotted on figure 2 represent



In this view, the pipeline is about 65 ft above the bent footings—bents are placed 24 ft apart. Trestle posts, knee braces and pipe supports are 6 by 6-in. untreated red pine timbers. Stringers, struts and sway braces are 2 by 8-in. lumber

the average friction loss over the total 4000 ft of line. The friction loss on the 2000 ft uphill section of the line was about 120 percent of these average values and the friction loss on the 2000 ft downhill section about 80 percent. This appeared to be true at all velocities tested. It should be noted that the average grade between the pressure gauges was 2.7 percent.

Since the maximum rate of pumping was to be 900 to 950 U.S. gpm the test work confirmed the previously formed opinion that eight-in. pipe was the size required for the proposed installation. This would result in a pipeline velocity of approximately six fps and a friction loss of 18 ft of pulp per 1000 ft of pipeline and this data was used in the design of the pipeline. With the choice of an eight-in. line and with the pump speeded for a friction loss of 18 ft per 1000 ft of line, a study of figure 2 would indicate that the line could be safely used at volumetric velocities below critical. At rates of flow below the critical velocity the friction loss becomes unpredictable, but is almost always lower than it is at the critical velocity. In other words, when sufficient head is provided to overcome the friction at or above the critical velocity it is sufficient to keep the line operating at velocities below critical. This is important because when part of the mill is shut down for repairs the line is expected to continue operating at a lower volume. In actual practice volumetric velocities as low as 3.0 fps have been used without difficulty.

Tests on the head-capacity relationship of the 8-in. by 6-in. SRL–C pump, as determined from the data on the eight-in. test line, confirmed the manufacturer's characteristic curve for water. The power requirements for this pump handling pulp were found to be equivalent to the power required to pump an equal volume of water against the same total head, expressed in feet, multiplied by the specific gravity of the pulp.

Location of Pumping Stations

After having established the friction loss in the pipeline, and using a profile of the proposed route from Creighton to Copper Cliff, it was possible to locate the pumping stations. There were four factors to consider in determining the maximum spacing of these stations: 1) permissible head on the pumps, 2) permissible pressure on the pipeline, 3) maximum practical height of trestle to provide a self-draining line, and 4) profile of the proposed route. The limiting factor in every case was the head obtainable from an 8-in. by 6-in. SRL–C pump, since it was decided to use single stage pumping due to limited experience with multiple-stage pumping at the time. Two new installations for pumping concentrate have since been put into service, using two-stage pumping, and these are operating satisfactorily.

Three new stations and trestle were required to bridge the four-mile gap between the Creighton mill and the Copper Cliff tailing disposal area. Their location was governed by the requirements of concentrate pumping, because experience with pumping Copper Cliff tailing had indicated that the tailing from the Creighton mill could be handled in a 13-in. wood stave line with a friction loss of only 15 ft per 1000 ft of line.

Over the remaining 3½ miles to the Copper Cliff mill, the eight-in. concentrate line was laid on existing tailing trestle. Existing tailing stations were used for pumping by enlarging them to accommodate the additional pumps needed. No additional personnel were required for this section of the line.

Completed Pumping System

Figure 3 is an artist's drawing of the completed pumping system between the Creighton and Copper Cliff mills. The stations with letter designations were built prior to the Creighton mill for Copper Cliff tailing dis-

Pumping stations are of concrete, steel and cement block construction and are essentially fireproof. The concentrate spill sump, in the near corner of the building, extends several feet below ground level. Building layout can be seen on the following page

posal purposes. Stations 1, 2 and 3 are the new stations built to handle Creighton concentrate and tailing. The concentrate is relayed to Copper Cliff from station 3, through stations E and C which were enlarged to accommodate the extra pumps and sumps required. Tailing is pumped from station 3 into the common disposal area. Table I gives pipeline distances and changes in elevation between pumping stations.

TABLE I

	Pipeline Distance	Changes in Elevation Between Stations
	(feet)	(feet)
Creighton mill to station 1	5,500	plus 17
Station 1 to station 2	6,965	minus 2
Station 2 to station 3	7,250	plus 4
Station 3 to station E	3,900	plus 44
Station E to station C	9,950	minus 45
Station C to Copper Cliff mill	6,450	minus 23

On the pipeline trestle there are two 13-in. tailing pipes and two eight-in. concentrate pipes. Only one pipe is required to handle each product, the second being a standby which can be put into service by manipulating valves at the pumping station. In addition to a lighted walkway on the trestle, there is a six-in. wood stave line that supplies water to the stations.

The new trestle was built to provide a minimum grade on the pipeline of 0.75 percent, so that the lines would be self-draining to a pumping station and require no flushing when shutting down. This required a high point in the trestle between stations which is usually about midway, but dependent upon topography. Part of the existing Copper Cliff tailing trestle which was used to carry the eight-in. concentrate lines has a grade of 0.50 percent, and this smaller grade has proven adequate for line drainage.

The three sizes of pipes carried on this trestle, six, eight, and 13-in., are of wire-wound, wood stave construction with banded couplings. The wood is kiln-dried Douglas fir, pressure creosoted at eight psi. The finished pipes are asphalt coated to prevent corrosion of the wire winding and to further protect the wood. The eight-in. and 13-in. pipes are designed for 100 psi pressure and the six-in. pipe for 75 psi pressure. The wooden walls of these pipes are 1⅛ in. thick.

Coupled Pipes Easy to Replace

Banded, wood stave couplings are used for this type of service because they permit a defective pipe to be removed without moving the adjacent pipes. Other types of couplings, such as the wood-sleeve and the twin-steel, are considered less suitable because, being assembled by driving one length of pipe into the next, it is harder to replace a defective pipe.

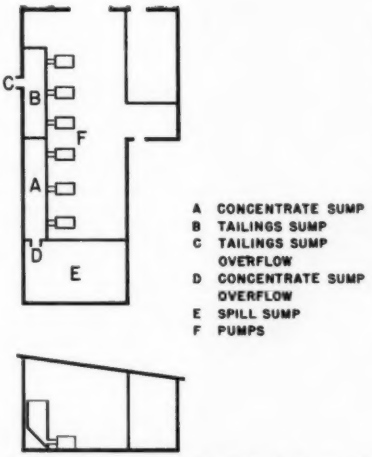


Fig. 4. Plan and cross-sectional views of typical pumping station layout.

The standard length of pipe is 16 ft, but sufficient eight-ft lengths are used to facilitate making bends and connections into stations. The following minimum radii of curvature are used for wood stave lines with eight-ft pipes:

Pipe Size (Inside Diam)	Minimum Radius
6 in.	80 ft
8 in.	120 ft
10 in.	150 ft
13 in.	175 ft
16 in.	200 ft

The life expectancy of these wood stave lines is at least 12 yr for the eight-in. concentrate lines and at least eight yr for the 13-in. tailing line. This is on the basis of continuous use of one line, 8760 hours per year. Since in actual practice the line is alternated in use with the spare line every month, these life expectancy figures will be considerably lengthened. There is no formation of scale in any of these lines and they have been in service since 1951.

Wood Stave Pipe Not Insulated

The heat loss from the wood stave pipe has proven to be sufficiently low that no insulation or protection from the weather is required on the lines handling pulps.

For example, when the eight-in. concentrate line is handling its normal volume of 800 U. S. gpm and the temperature of the pulp leaving the Creighton mill is 50°F, it will reach Copper Cliff, 7½ miles away, at about 35°F, when outside temperature is 30°F below zero, with no wind. This is equivalent to 2°F per mile of line. On rare occasions, sub-zero weather with a strong wind (such as 40 mph) will cause a temperature loss of 3° per mile. This necessitates adding steam to the pump box at the Creighton mill in sufficient quantity to keep the temperature of the pulp above 32° as it enters the Copper Cliff mill. The six-in. pipe which supplies water to the stations has been housed in a box insulated with wood shavings because it carries unheated river water.

In the new pumping stations concentrate and tailing sumps are arranged along one wall (figure 4). In cross section they resemble an inverted right-angle triangle with a width across the top of 5½ ft and sufficient depth to provide a head of 5¾ ft on the pump intakes when the pulp level is at the emergency spill weir. The spill weir on the tailing sump leads outside the station; that on the concentrate sump leads to a spill sump located across one end of the building. The capacity of the spill sump provides for draining the concentrate lines three times in succession in case of successive power interruptions or other unusual trouble. The content of the spill sump is reclaimed by means of a Canadian-Allis-Chalmers 3-in. by 3-in. SRL–V pump which is suspended on a chain block so that it can be raised out of the way or lowered into the pulp as required.

100 and 200-HP Pumps

Pumping station 1 (figure 5) has three 8-in. by 6-in. SRL–C pumps with 100-hp motors for concentrate service, and three 10-in. by 8-in. SRL–C pumps with 200-hp motors for tailing service. One pump on each service is sufficient for normal requirements. Each pump has two discharge valves so that it can deliver to either of the two pipelines. Each of the three pumps at each station on both tailing and concentrate has a different speed. The speed of the slowest pumps was calculated to overcome a friction loss of 18 ft per 1000 ft of pipe in the eight-in. concentrate line, and 15 ft per 1000 ft of pipe in the 13-in. tailing line. Medium speed pumps run at 50 rpm faster than the low speed pumps, and the high speed pumps run at 100 rpm faster than the low speed pumps. The low speed pumps are the normal operating pumps and the higher speed pumps are used only when operating conditions, such as changes in pulp density, surges in volume and partially

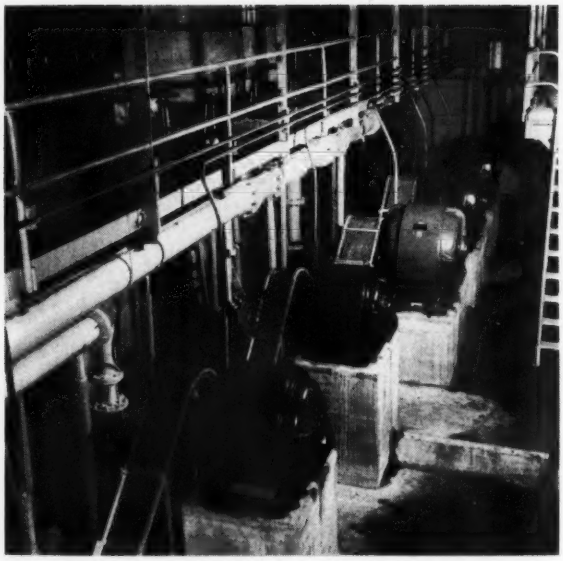


Fig. 5. View inside pumping station 1. Each of three concentrate pumps and three tailing pumps has a different speed. One pump on each service is sufficient for normal requirements. Note valves extending through upper floor grating; these permit control of the discharge to either pipeline

plugged lines require higher pump pressures. Variable speed drive for the pumps does not appear to be necessary for this type of service. Life of the rubber-covered runners in the 8-in. by 6-in. SRL–C pumps has averaged 6000 operating hours and the life of the casing liners has averaged 8750 operating hours.

The six-in. water line supplies potable water to the stations and provides gland sealing and flushing water for the pumps and pulp lines. The water is received at each station in a 1000-gal tank which will supply gland water to the two operating SRL–C pumps for approximately one hr in the event of failure in the water service. A water pump at each station draws water from the tank and delivers it to the pump glands at 90 psi pressure.

Recording pressure gauges are used in each station to provide a continuous record of pipeline pressures on both concentrate and tailing lines.

Tests on Completed Pumping System

Tests for critical velocity, friction loss and power consumption were made on the concentrate pumping system 2½ years after its completion. The procedure was similar to that described in connection with the eight-in. test line. The rates of flow were determined by discharging the line under test into the spill sump. The tests covered three different sections of the line: Creighton mill to station 1, station 1 to station 2 and station 3 to station E.

A critical velocity of 6.0 fps was obtained from this test work and this confirms the results obtained from the eight-in. test line. However, the friction losses for rates of flow up to 850 U.S. gpm, which was the maximum rate obtainable in the tests, were all under 13 ft per 1000 ft of line. These are lower losses than obtained on the eight-in. test line where at rates of flow up to 850 U.S. gpm friction losses as high as 18 ft per 1000 ft of pipe were obtained with most tests being over 13 ft per 1000 ft of pipe. The reason for this discrepancy in friction loss is puzzling, particularly in view of the identical critical velocity obtained on the test line and on the operating line. Identical pipes were used in each case. The size analysis, mineral content and specific gravity were similar in both cases. However, the test line had a grade of 2.7 percent to and from the high point compared to 0.75 percent on the operating line, and possibly this might account for the lower friction loss in the operating line.

Screen analysis of the Creighton flotation concentrate is given in table II:

TABLE II

Mesh	Flotation Concentrate % by Weight	
	This Mesh	Cumulative
plus 48	0.9	0.9
plus 65	4.4	5.3
plus 100	10.9	16.2
plus 150	12.9	29.1
plus 200	8.5	37.6
minus 200	62.4	100.0

Specific gravity of the dry material is 3.9, and pulp densities range from 25 percent to 35 percent solids.

Operation of Pumping System

The concentrate lines give very little trouble in operation. Occasionally conditions will arise when one pump will not handle the quantity being delivered from the previous station and a second pump is put into service to operate in parallel with the first one. Such a condition is most likely to occur when the rate of flow is increasing to normal after having been low for a period of time due to a decreased milling rate.

Continually fluctuating pulp density amounting to five points or more on the percentage solids scale are normal. This is caused by the accumulation of concentrate which works along the line at regular intervals. Fluctuating pressures are also normal on the eight-in. concentrate line and are apparently caused by this fluctuating density. The recording pressure gauges at any of the pumping stations show a continual fluctuation in pressure at a rate of four to six cycles per hr and having an amplitude ranging from one-fifth to one-third of the mean pressure. The ammeters on the pump motors also follow this cycle. Fifty-five psi is the approximate mean pressure at all the stations.

The concentrate is switched from one line to the other once per month, except in freezing weather when it is not considered necessary. Thus each line is used during alternate months and this prevents the pipes from drying out. When a line is taken out of service no special precautions are taken except to let it drain. No flushing is required.

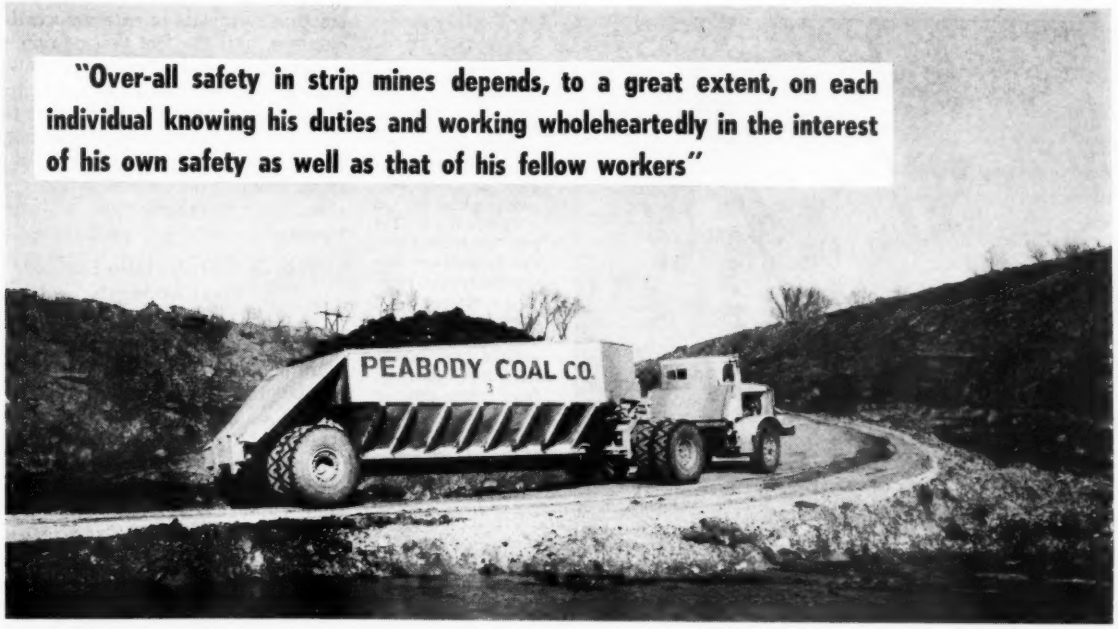
Each of the spare pumps is run for several hours each week in order to keep the motors dry and to ensure that everything is in good order.

Personnel

Stations 1, 2, 3 and E each have one man in attendance at all times to operate the station. Repairs in these stations are made by a day shift mechanic who is assisted by the station attendant. Stations C and D each have two attendants at all times, a qualified mechanic and his helper. These men operate the stations and make all the repairs required within their stations.

Three men constantly patrol the 7½ mile line, each man covering his section of the line four times in an eight-hr shift. Each patrolman carries a hammer and small wooden wedges so that if a leak develops he can stop it before it develops to serious proportions. If the leak is too serious to stop in this way, he can go to one of the conveniently located telephones and instruct the station attendant to pump through the spare line.

The pumping system is at all times under the supervision of a boss who is responsible to the mill foreman. The boss patrols the line and normally visits each station every shift.



SAFETY PROBLEMS Involved in STRIP MINING

By EUGENE E. QUENON
Director of Safety
Peabody Coal Co.

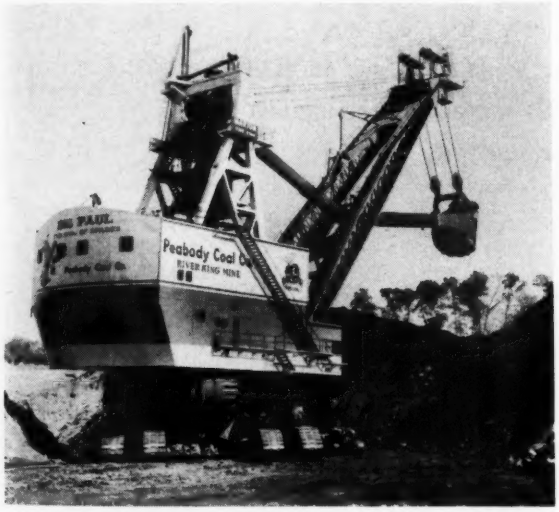
PERSONS not fully familiar with coal mine stripping methods, particularly those who have not worked in the pits during adverse weather conditions, sometimes form an impression that stripping coal is a simple matter of removing layers of dirt and rock from the coal beds and scooping up the coal with little or no difficulty. Because the safety records in strip mines have always been enviable when compared to deep mining, one is also likely to take for granted that serious hazards seldom exist in strip mines and, if and when a hazard does exist, it can be eliminated by a few safety measures.

Shortly after being employed by Peabody Coal Co. as director of safety and assigned some of the responsibilities of preventing injuries in the strip mines, the writer had a rude awakening to the fact that hazards in the strip mines were numerous, many of which were complicated and decidedly dangerous.

While many hazards exist in strip mines under normal mining conditions, many of these same hazards become much more serious under adverse weather conditions and, in addition, new hazards are developed. The seriousness of the hazard, in many instances, is directly in proportion to surrounding conditions and cannot be entirely eliminated without the assistance of improved weather. Because of this, the weather has a direct bearing on the frequency and severity rates of injuries in stripping and processing coal.

Greatest Hazard Is Sudden Changes in Weather

The following example will serve to point out the effect of severe weather changes in the operation and maintenance of a strip mine. During the fall of 1958 an inspection was made of one of Peabody's larger strip mines. The weather was ideal and conditions of the pits, haulage roads, equipment, shops, cleaning plant, newly painted buildings, nicely kept lawns and yards seemed to coincide.



Falling or rolling materials from the highwall can become extremely hazardous unless the cut is properly blasted and the loose material is removed during the time of stripping operations. Spoil banks, unless properly stacked, will present an equally hazardous condition from rolling material

A similar condition existed in almost all of the strip mines visited during the inspection trip. A confident feeling existed to the effect that real progress was being made toward an over-all improvement in safe working conditions which would ultimately result in a much lower injury frequency and severity rate.

About five weeks later, the surface had thawed following a prolonged cold spell in which zero weather had frozen the surface to a depth of about 15 in.; the pleasant surroundings observed a few weeks earlier had indeed changed to such an extent that conditions throughout the operation seemed to invite accidents. The hardships caused by the muddy conditions not only created new hazards but were indirectly responsible for several breakdowns of equipment. The overall conditions actually appeared to discourage men and management from following the adopted safety practices that were normally in effect.

Other than the main haulage roads and uncovered coal, the surroundings were a mass of mud that definitely retarded the entire mining operations and new hazards were created. Highwalls and spoil banks now presented a definite hazard from falling or rolling material; handling power cables in the mud was much more hazardous; walking and working under such conditions caused fatigue, resulting in a lack of alertness. Of the three bulldozers used at this mine, one was in service, one was mired down, and the third had broken down that morning and was out of service.

Several workmen were changing a crawler axle on the large stripping shovel, exposed to the conditions caused by the thawing which were definitely conducive to accidents. Indeed, the entire picture had changed to the extent that anyone would wonder how a repair job could be done without accidents and injuries.

The consensus of opinion among the majority of strip mine officials consulted regarding the greatest hazards involved in strip mining was that the sudden changes in weather, such as heavy rains, zero temperatures and thawing of the surface following long periods of freezing, were conducive to accidents. Frequently a heavy rain will completely flood a pit, necessitating the setting of pumps and the moving of equipment to higher ground, and causing slides along the spoil banks and loosening highwalls. When the mining operations resume, it is some time before the operation is back to normal, thus exposing employees to abnormal hazards.

Zero temperatures in the open pits also do much to retard the operation and can have much to do with the frequency of accidents. One of the superintendents explained his reasons why an employe is subject to injury during low temperatures: "His ears are covered up, he can't hear. He sometimes has his face covered up to where he can hardly see. He is so cold that he is numb and has but one thought in mind—that is to get the job done and get thawed out." The superintendent might have exaggerated a little but he is not too far wrong.

It was also the consensus of opinion that more breakdowns occurred in the winter months than in warmer weather. The reasons advanced were due to a greater expansion and contraction of metals in extreme weather changes, plus the fact that equipment working in mud and water had a tendency to overload the capacities. Peabody's experience in the past two years shows that a large percentage of its more serious injuries resulted from doing repair work in the open pits during periods of inclement weather.

Built-in Features Help Eliminate Plant Accidents

The seriousness of safety problems involved in a modern preparation plant depends to a great extent on the construction, maintenance and operation of the plant. In recent years, Peabody has constructed several modern preparation plants, building into them certain features that will enable management to operate them safely and efficiently.

While these tipples or cleaning plants are built with the most modern equipment to provide maximum safety and efficiency, these modern devices will only help to eliminate accidents. Constant supervision is necessary to make certain that the personnel think and work safely at all times. Only when each employee has been trained in his routine work and the plant is being operated under normal conditions are the chances of an employee being injured unlikely.

River Queen mine was Peabody's top producer in 1958 and because it is of modern construction and similar to some of the other plants operated by the company, it will serve as an example to describe briefly the importance of including in the construction of a cleaning plant certain features to increase the efficiency of the plant and eliminate hazards.

The River Queen preparation plant is of fireproof construction throughout; all electrical wiring is in closed conduit, and motors for driving the various pieces of equipment are moisture-proof. The equipment is so arranged as to provide adequate room to safely do maintenance and repair work. The moving parts of the equipment are adequately guarded. Stairways and crossovers are installed at convenient locations and are guarded with hand rails. Floors, stairways and crossovers are, in most instances, constructed with metal grill, thus eliminating accumulation of coal and dust. A series of water jets, spaced about 30 in. apart, are installed on the ground floor for cleaning purposes.

Plant is adequately lighted throughout by windows and incandescent

lights, and provisions are available for heating in cold weather. The entire plant can be cleaned with water without damage to equipment. Switchboards and control panels are provided with rubber mats and the equipment is controlled by a series of pushbuttons from a central location. Fire extinguishers suitable for electrical fires are placed at strategic locations. A railroad car spotter controlled by pushbuttons eliminates the hazards involved when compared with the conventional methods of workmen dropping railroad cars by gravity.

The most hazardous period in the preparation plant is believed to be while repairs are being made to equipment following a breakdown—usually because those doing the repair work are in a hurry to get the plant back in operation and do not take time to do the job in the safest possible manner.

Competent Drivers Key to Safe Haulage Operation

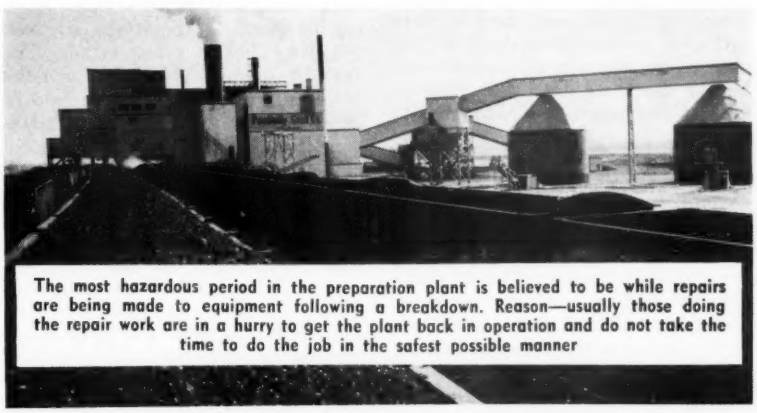
Trailer trucks with capacities as high as 70 tons are used for transporting coal from the pits to the preparation plant. The safe and efficient operation of a transportation system at a strip mine depends almost entirely on a competent driver. The safe condition of the truck, maintenance of haulageways, and obedience to rules and regulations governing the movement of trucks are contributing factors to the safety and efficiency obtained.

You can best appreciate the responsibility of the operator of a trailer truck if you take a trip with him to the pit. Under ideal weather conditions, there would be nothing unusual about the trip except perhaps the driver may complain about a few rough spots on the road and occasional dusty conditions.

Take a similar trip in the same truck with the same driver following a heavy rain, or after the ground has thawed following freezing weather. On this trip you will really learn about some of the hardships which are encountered in strip mines due to adverse weather conditions, not only by the operator of the truck but by everyone working in and around the pit. The haulageways which were in A-1 condition prior to the change in weather are now covered with two or three in. of soft material. The inclines into and out of the pits, which are only temporary haulage roads, are now slick and muddy. In some instances, the trucks are pushed into and out of the pits by bulldozers.

The driver on this trip may complain about not having power steering or about the weather. However, realizing that little can be done about such conditions, he continues to do his work, exercising perhaps much more caution than he feels necessary under normal conditions.

Traffic regulations governing the movement of vehicles are, in most instances, strictly followed by the truck operators. The crossing of railroads and public roads is done with great caution. Officials and other key employes who are required to travel by automobile over the same routes as the coal trucks offer no serious problem as they are familiar with the hazards involved and will give the right-of-way to the coal hauling equipment. Visitors not familiar with the operation of traffic in the strip pits should observe the posted signs reading "No Trespassing". And when it is necessary to enter the pits, they should be accompanied by a person fully familiar with the transportation system at the mine and the regulations in force.



The most hazardous period in the preparation plant is believed to be while repairs are being made to equipment following a breakdown. Reason—usually those doing the repair work are in a hurry to get the plant back in operation and do not take the time to do the job in the safest possible manner

Improved Drilling Equipment Has Eliminated Many Hazards

Overburden ranging in thickness from 20 to 100 ft, in most instances, must be drilled and blasted. Whether holes are drilled vertically or horizontally, much consideration must be given to the safety aspects as well as to the effectiveness and practicability of the adopted method. Without taking the practicable viewpoint into consideration, drilling holes vertically from the highwall would appear to favor the safety aspect, because the drilling crew would not be exposed to the hazards of falling or rolling materials from the highwall; and the explosives, drilling equipment and power cables would be out of the pit and separated from the normal pit activities.

Whether the overburden is drilled vertically or horizontally will be governed to a great extent by the character of the various formations that make up the materials to be blasted and the surrounding conditions. Irregular surface, unconsolidated top material, and heavily wooded areas make vertical drilling, in some instances, inefficient and impracticable.

The over-all improvement in the heavy equipment employed in both horizontal and vertical drilling has not only added to the efficiency of drilling but has eliminated many of the hazards common to conventional drilling. These larger drills are operated from an enclosed cab, thus protecting the driller from exposure to inclement weather, as well as other hazards to which drillers are exposed when working in the open.

Adoption and Use of Ammonium Nitrate Improves Safety

One of the most important advancements in the improvement of safety in strip mines in recent years has been the adoption and use of commercial grades of ammonium nitrate as an explosive for blasting heavy overburden. The increased use of ammonium nitrate explosives since 1955 has been a major safety factor in the way of eliminating the hazards that are inherent in the transportation, handling, storage and use of explosives containing nitroglycerines. The use of a safe primer, detonated with Primacord in connection with ammonium nitrate explosives, is also a big safety improvement when compared with methods employed in the past.

Ripper attachments mounted behind a heavy-duty crawler tractor are

used in several of Peabody's strip mine pits to break up the coal beds prior to loading. Eliminating the necessity for blasting coal also does away with the hazards in the use of conventional-type explosives.

Although many of the hazards have been eliminated with the use of explosives containing non-nitroglycerines, the same precautions employed in the transportation, handling, storage and use of dynamites are the recommended practice at Peabody's mines. At all of these strip mines where it is necessary to blast overburden, ammonium nitrate explosives are used. However, some of the strip mines continue to use dynamites for blasting coal beds where rippers are not in use.

Peabody has in service several machines that are used for loading and tamping horizontal holes. These machines eliminate the hazard of having three or four workmen charging and tamping a single hole with a plunger attached to aluminum rods. Vertical holes are generally charged immediately after drilling and fired between shifts, or as soon after the holes are charged as is practical. Before overburden shots are detonated, the surface of the highwall is inspected to ascertain that everybody is well in the clear. Entrances into and out of the pits are patrolled to keep others in the clear. The operators of the shovels or dragline give a warning whistle when a blast is to be fired. A second signal is given after everyone has had time to get into the clear. The charge of explosives is fired immediately after the second warning signal.

Constant supervision is necessary to make certain that explosives, regardless of the type, are transported, handled and used in a safe and careful manner. When this is done, the full benefit of the safety built into explosives can then be reaped.

Through engineering data, core drilling and other available information, suitable stripping shovels, draglines and other equipment are selected for use at the various mines in accordance with the depth of the overburden, characteristics of the material to be removed from the coal bed, and with the surrounding conditions. Falling or rolling materials from the highwalls can become extremely hazardous unless the cut is properly blasted and the loose material is removed during the time of stripping operations. Spoil banks, unless properly stacked, will present an equally hazardous condition from rolling material. Stripping overburden from the surface of a highwall with a dragline will, in most instances, leave the highwall free of loose materials.

Overburden composed entirely of sand, clay, and saturated with water, creates a difficult problem in stacking and presents a serious hazard to workers in the pit. Materials made up of such a composition have been known to flow across the open pit with such rapidity as to cover up persons working around the equipment.

The over-all safety in the strip pits depends, to a great extent, on each individual knowing his duties and working wholeheartedly in the interest of his own safety as well as that of his fellow workers.

Ways to Minimize Electrical Dangers Cited

Electricity ranging in voltage from 110 to 6900 a-c presents a serious shock and electrical burn hazard to the majority of the employes at a mine. The hazards from shock and burn are much more serious when the surrounding conditions are wet, following heavy precipitation. The use of insulated cable hooks and the wearing of insulated shoes and gloves will minimize the ever-present dangers from electricity at the strip mines.

Employes are instructed to call the mine electrician when electrical equipment is in need of repair or when connecting or disconnecting power conductors. When employes realize the seriousness of high voltages, fewer chances are taken when working around power conductors.

Erecting, dismantling, moving or repairing heavy stripping equipment is an everyday procedure with Peabody's organization. This type of work is extremely hazardous, especially during inclement weather, and has resulted in several serious injuries in the past. Fortunately, supervisors assigned to this type of work are thoroughly skilled in their art and, through their past experiences and knowledge of the hazards involved, injuries are reduced to a minimum.

General repair work on all types of equipment at the various mines is done daily and those assigned to such work are highly trained through many years of experience. Capable supervisors are employed at each strip mine. They direct the repair work and make certain that the job is done in the safest possible manner.

Employes Encouraged to Work Safely at All Times

Federal and State mine inspectors have been of much help in the elimination of substandard safety conditions in and around Peabody's pits, shops and cleaning plants, and few violations of the State laws and Federal Mine Safety Code are reported by these agencies that cannot be corrected during the inspection. These agencies have, in most instances, done an outstanding job in helping to bring about better co-operation between men and management in the interest of safety and accident prevention.

Progress will continue in the reduction of injuries and fatalities in the company's strip mining through the improvement of equipment and the continued efforts of men and management to fully co-operate in the interest of preventing accidents. The elimination of sub-standard safety conditions in Peabody's strip pits is not far from reality.

Therefore, the company's future safety problem involved in strip mining is to encourage employes and officials to work safely at all times and to take no unnecessary chances.

How about an Anthracite Posture, and a Bituminous Smile?

A progressive company located in the rugged San Juan Mountains of southwestern Colorado has been blessed with few natural advantages, but through the efforts of an alert staff, it has proven it can weather a storm of considerable severity and today looks forward to many years of successful and profitable operation

By A. C. HILANDER
General Superintendent
Idarado Mining Co.

Since 1956 productivity of Idarado stope miners has been increased from 38 tons per machine shift to almost 50 tons

A REVIEW OF RECENT IDARADO ACTIVITIES

SUCCESSFUL operation of any low grade underground base metal mine, even during periods of stable and adequate metal prices, hinges on several basic factors, namely; a favorable geologic pattern of the ore deposit conducive to inexpensive mining; a simple ore amenable to modern metallurgical extractive methods and high recoveries; reasonable proximity of the operation to smelters; a favorable labor market; and a cost-conscious and progressive management team. During periods of depressed base metal markets, the importance of these factors is considerably magnified.

Production Curtailed To Conserve Ore Reserves

In 1957 the decline of the base metal markets forced the operators of base metal mines to important and sometimes drastic decisions. There were the choices of closing down the operation, curtailing production, gutting the mines in order to maintain profit margins, cutting costs and increasing efficiency, or possibly combinations of these. Idarado Mining Co. chose the expedient of cutting costs, increasing efficiency and curtailing production some 16 percent, the latter in an effort to conserve ore reserves and do its part to relieve the existence of a glutted metal market.

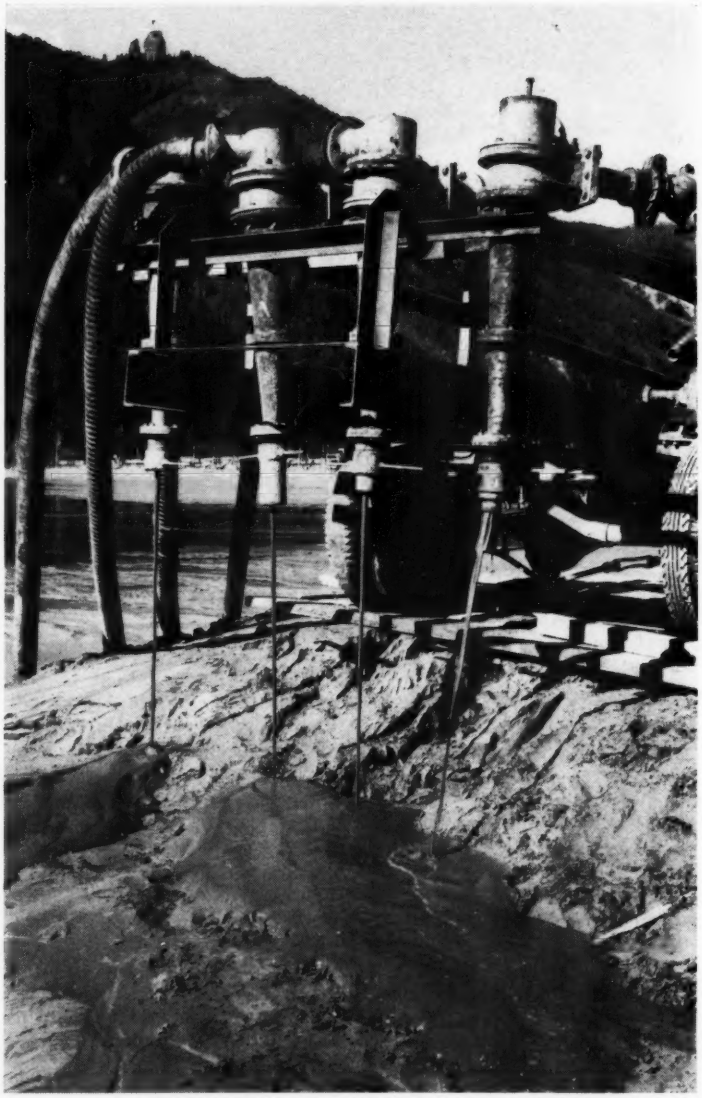
To briefly review the mining operation, present day activity is limited to mining on 10,000 ft of strike length and 2600 ft of dip distance on the Argentine vein, a relatively steep dipping fissure type vein; and mining on 5000 ft of strike length and 2600 ft of dip distance on the Black Bear vein, a flatter dipping fissure vein splitting off the southeast extremity of the Argentine. The elevation of this mining area ranges from 9500 ft to over 12,000 ft above sea level.

Access to the mine may be gained through either of two active portals, the Mill level portal at Pandora at elevation 9070 ft or the Treasury tunnel portal on Red Mountain at elevation of 10,620 ft. These portals are 5½ miles apart *through* the mountain or 64 miles by highway *around* the mountain. As all the workings are inter-connected by drifts and raises, access to any area in the mine may be had from either portal. Roughly half the underground force enters from each portal. On the average 1½ hr of each of the two underground shifts is consumed in travel time, leaving less than 6½ hr of effective working time available per shift.

Mineralization of the complex ores of the Black Bear and Argentine veins differs only in the quantities and proportions of gold and silver and lead, copper and zinc sulfides present; but mining on the Argentine is complicated by a barren pre-mineral dike accompanying the vein. This dike may swing from one wall to the other and causes heavy dilution when broken.

Efficiency Index Developed

The mine is developed by tracked levels spaced 400 to 500 ft apart on the vein and long raises spaced 400 to 800 ft apart, also on the vein. Over a decade ago, shrinkage stoping, incorporating sublevel slusher drifts for drawing the ore, was adopted as the



A truck-mounted manifold of cone-type classifiers is used to build sand berm on the tailings pond at Pandora

cheapest and most logical mining method. Stopes 200 to 250 ft long are mined on either side of the raises. Service is either up the raise or down the raise—whichever is most convenient. When a stope has been mined up a distance of 200 to 250 ft, a crown pillar is left, a sublevel slusher drift driven and prepared, and another stope mined above the lower completed stope. All broken ore for the mill eventually reaches Mill level through a series of strategically placed long ore passes from which it is gathered by the haulage crews. Mining, whether it be stoping, raising or drifting, is on an incentive system based on tons of ore broken, as in the stopes; or on feet of advance, as in the drifts and raises. Mill tonnage is currently at the rate of 34,000 tons per month.

At the time of the onset of lower metal prices in 1957, the company was aware of the high cost of spreading crews too thinly throughout the great extent of the workings. More service personnel were needed in order to cover the area, supervisors spent most of their time traveling from one working place to another, and maintenance of air, water and power facilities was excessive. Accordingly, all mining effort was concentrated in three main areas carefully selected to produce a balanced mill head with average run-of-mine ore. An efficiency index was developed which is merely a number expressing the ratio of underground service personnel, such as hoistmen, nippers, timbermen, powder men, mechanics, etc., to production miners. All planning is done with this index in mind. Since the development of the index in 1957, the ratio has been reduced from almost five to one to a fraction over three to one.

Operating Innovations

At present, wherever possible, two stopes are mined simultaneously from a single service raise. Not only does this halve the number of nippers necessary to service the stopes, but it actually stimulates competition between the crews to out-produce each other. By the introduction of faster drilling single use carbide bits and improved steel to accompany them, productivity in the stoping operation has been increased from 38 tons per machine shift to almost 50 tons, and bit and steel costs have been substantially reduced. By drilling smaller holes and loading with smaller diameter powder, yet maintaining the same burden as with the larger holes, drilling speed has been further increased and powder costs maintained despite increased powder costs from the manufacturer. Lower grade explosives with improved tamping features have been tested and ultimately adopted to hold the line still further on explosives costs.

In the stope preparation phase of the operation, it has been found that where formerly a two man crew had been used to drive each slusher drift heading, two headings can be driven back-to-back off the same service raise with the one crew, each man drilling, blasting, and slushing his own round, each shift.

In the development phase improved raise and raise timber specifications have made it possible for good raise miners to drive long raises (400 to 800 ft) and advance a six inch round and a set of timber each shift. Drift crews are expected to make a complete six or seven ft cycle each shift. All development crews advance their own air, water and vent pipe, and also their own blasting and signal systems by means of simple prefabricated plug-in connections.

Successful Cost Cutting Campaign

In addition to the advances made in operational details underground, every effort has been made to eliminate wasteful practices. Timber sizes and lengths have been standardized, old hoist and tugger cables are reused for slusher rope, discarded drill steel is made into eye-pins, pipe

A 17-ton trolley locomotive converted to diesel-electric by Idarado shops pulls 31 four-ton cars with ease

hangers and wedges, and inventory items are carefully controlled and purchased. The company prefers to have an adequate cash reserve rather than having its funds tied up in excessive inventories.

The Mechanical Department and Engineering Department have made great strides in standardizing maintenance and preventive maintenance procedures and in developing, designing and testing new and better equipment for both mine and mill. Through their efforts drill steel life has been doubled, and an extremely effective 17-ton diesel electric locomotive has been designed, built, and is now in service on the main line haulage. Minor improvements in certain features of both battery and diesel haulage locomotives and accessory equipment have resulted in substantial savings to the company.

While these improvements have been made in the underground operation, the Mill Department has also forged ahead with a program aimed at improved extraction, improved filtration, a higher level of preventive maintenance and improved tailings disposal, all pointing in the direction of greater dollar return from the ore and lower mill costs. That this campaign has been eminently successful is evidenced by the fact that milling costs have been reduced 20 cents per ton in the face of rising supply costs during the two year interim period since the downward slump of metal prices.

A well-equipped test laboratory is maintained for use in developing new ideas. Work is progressing at all times to determine optimum concentrate grades and distribution of metals within the various concentrates consistent with low tailings losses and maximum smelter return; optimum grind for best results throughout the circuits; and lowering of moistures in the filter products to cut down on freight costs for the long hauls to the smelters.

A system of building sand berm on the tailings dam during the summer months by means of a truck-mounted manifold of cone-type classifiers enables the mill to dump tailings for ten months of the year with a minimum of attendance and expense.

New Employes Carefully Screened

Finally, we feel that we have an excellent crew at Idarado. This is partly the result of training and partly a result of careful employe screening by the hiring foreman. All prospective employes are required to fill out application blanks after an initial interview, and their references are carefully investigated for their job capability, absenteeism records and safety record. Then they are required to pass a rigid physical examination before they are assigned to work. We believe that this system has paid off, for in 1956 in order to maintain a crew of 431 men, an average of 32 men were hired per month; and in 1959 in order to maintain a crew of 300 men, an average of 6 men were hired per month. Absenteeism has declined from well over 6 percent in 1956 to 4.2 percent in 1959 for the operation as a whole.

In some respects the problem presented by the state of the base metal mining industry over the past two years has been good for us, for not only has it stimulated ideas, but it has made the entire supervisory staff cost-conscious, and we feel that we have a better and more efficient operation for it.

In closing, I might say that this article has been intended only as a general review of what Idarado has been doing to remain in operation during a very trying period; there is no doubt that much more will be done in the future. It is our firm conviction that a more extensive exchange of operating ideas, however small, within our segment of the industry would be a wholesome and beneficial development. Only through this type of liaison can we mutually share our advances.

Pandora surface plant at Telluride showing mill in foreground and Mill level portal (elev. 9070) at extreme left

By WILLIAM LAIRD

Superintendent
Federal No. 1 Mine

Eastern Gas &
Fuel Associates

MAINTENANCE of CONTINUOUS MINING EQUIPMENT

The introduction of any new equipment brings with it new problems that must be solved. The continuous mining machine was no exception. Since its introduction, manufacturers and operators alike have devoted much time and money on improvements that have meant greater productivity and safety. The following article spells out one operator's approach to the major problem of maintenance

EASTERN Gas & Fuel Associates has six Goodman "400" d-c continuous mining machines, one Goodman "400" a-c and one Goodman "500" d-c in operation at its Federal No. 1 mine, Grant Town, W. Va. The purpose of this article is to recount the company's experience with these machines, emphasizing some of the improvements that have been developed over the years through the efforts of both the manufacturer and the coal company.

Some Production-Delay Causes

The company's "500" machine has mined 1,312,058 tons without a major overhaul. This model cuts an entry 7 ft high and 13 ft 2 in. wide. There are three arms per rotor, and each arm telescopes and retracts six in., which facilitates tramming. The cutter arms can be located at any interval the seam cutting condition requires. One arm on each rotor cuts three kerfs. Bit holders are of the original design, consisting of individual blocks welded on the cutter arms. The small core burster cuts a core approximately seven in. in diameter.

This machine has not given the company much trouble; most of the production delays being caused by:

1. **Changing worn out and broken bits.**
2. **Welding new bit holders on arms.**
3. **Original clutch—too light for this application.**
4. **Original trim chain guides—too hard and brittle.**
5. **Original tramming gear reduction unit—too light for this application.**
6. **Cat tracks—wore out and had to be replaced.**
7. **Bit motor leads—vibration caused them to short and burn loose.**
8. **Hydraulic connections, valves, motors and pumps.**

On the "400" continuous mining machine, the long outer folding cutter arms are located at right angles to each other, as are the shorter cutter arms. The cutter arms are located to cut three kerfs—a center kerf, one intermediate and one outer kerf—and the machine's cutting height can be changed six in., three in. on each arm. The trim chain sprockets can be extended or retracted. Core bursters are almost nine in. in diameter.

Company experience with the "400" machines shows most production delays have been caused by:

1. **The 100-hp bit motor—particularly brushes and brush holders, excessive armature shaft spline wear and "V" ring grounding.**
2. **The 50-hp pump motor—particularly bearing failures, causing armature and armature shaft failures.**
3. **First three reduction gear shift shaft and bearing failures.**
4. **Hydraulic connections, valves, motor and pump.**
5. **Replacement of worn out and broken bits.**
6. **Replacing bit holders on cutter arms.**

Extending the Life of Rotors

To extend the life of rotors Eastern Gas is having the folding arm "hinge" bored oversize and a bushing inserted, wearing surfaces chromed, and a hardened pin installed. This work has had to be done on one of the machines after it had produced 416,497 tons and on another at 750,000 tons. Wear depends upon the metal in the arms and the physical conditions under which the miner operates.

Federal No. 1 mine's "500" boring type machine has mined 1,312,058 tons without a major overhaul. It cuts an entry 7 ft high and 13 ft 2 in. wide

In one case a rotor was relocated 45° on its splines to extend the intermediate arms without interfering with the outer rotor arms and at the same time obtain better spacing of kerfs and reduce lateral racking. This change led to increased penetration and production.

Experience With the A-C Machine

Rotor arms on the "400" a-c unit are located at an angle of 37½°. This angle gives greater flexibility in setting kerf pattern and makes it possible to relocate cutter arms to satisfy mining various seam conditions. A second intermediate arm can be installed if needed.

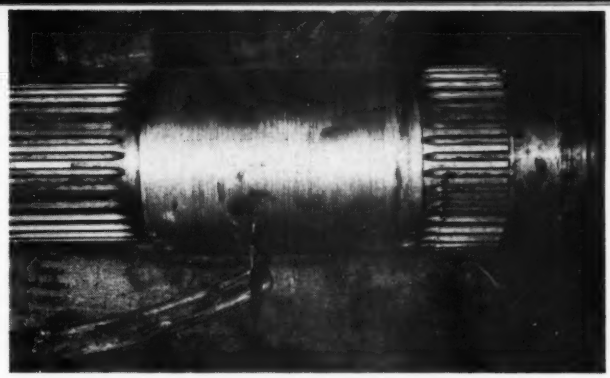
Heavier Bit Holders Needed

Sulphur and clay vein intrusions, which actually replace all of the coal at times, retard penetration, break and dull bits, and cause bit holders to be knocked off the arms resulting in lost production and increasing maintenance time and problems. The coal company's constant complaint and request for bits and bit holders to stand up under all Pittsburgh seam conditions brought about the development of a heavy bit holder which provides recesses for the installation of three tapered shank bits. The bit holders cost about $52 each.

This heavy bit holder, which was designed to hold three tapered shank bits per block, did not last long under the adverse cutting conditions. It failed because it was too soft, permitting the holes to become oblong. This made it impossible for the bit holder blocks to retain their bits.

In another attempt to reduce bit holder maintenance, a one-piece bit holder was employed. It was welded to a cutter arm designed to hold eight bits. The bits were secured in the bit holder by pins. Here again the bit holder was too soft. Bit holes became badly worn and bit breakage increased. Also, the greater number of bits retarded penetration. The pins often bend, making it necessary to cut the bits out of the bit holder with a torch, resulting in excessive bit changing time.

Eastern Gas & Fuel designed a bit holder for the core burster. A one-piece ring, the core burster cuts a 2½ to 3-in. kerf, 16 in. in diameter. Tapered shank bits are used and the results have been excellent. The company has operated as many as 20 shifts without changing a bit. Set screw difficulties have also been eliminated. Designed to give rugged service, the bit holder is heat-treated to a hardness of 58 Rockwell.



A ten-in diameter rotor shaft had to be removed because it had become badly scored by metal cuttings carried by the oil in the main gear case. To prevent this condition from recurring, the company is flushing the gear cases every six months

One other experiment should be described at this point. A roller type bit was tried on the coal company's a-c continuous mining machine. Initial machine penetration into the coal was at a rate of eight in. per minute. Upon conclusion of a 25-ft advance, penetration was reduced to four in. per minute, and two of the rotor cutters were lost. It was concluded that bearing and lubrication were needed for the rotor cutter. Pins became so hot that the carbide cutter fused to the pin. Pin keepers were lost, causing the pins to work out. It was decided that coal could be cut by this type of bit but that a lot of study and experimenting remains to be done.

Gear Train Redesigned to Minimize Wear

In regard to the gear case of the early "500" machines, the following should be noted:

(1) The tilt or elevating cylinders are mounted inside of the gear case. This means that any repair work on the cylinders requires removal of the lubricating oil and the complete dismantling of the gear case.

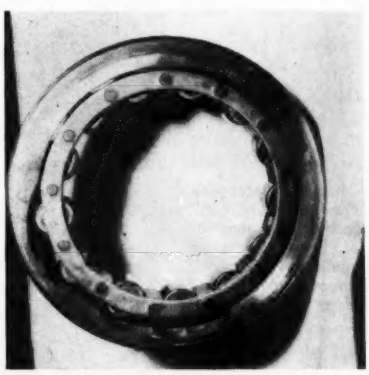
(2) Main rotor shaft rotates inside a bearing. This is a trouble free feature.

(3) Trim chain drive sprocket is keyed directly to the shaft. When the key is sheared the shaft is destroyed.

The drive sprocket is now driven through a shear pin arrangement, with the drive hub keyed to the shaft. The pin will shear before the key will, thus saving the shaft and eliminating a tough repair job. In addition, the elevating cylinders are located outside of the gear case and bolted to it so that they can be easily replaced, expediting maintenance.

In the gear train of the "400" d-c continuous mining machine, most wear is experienced in the first and second reduction gears and pinions. The manufacturer has redesigned its gear train, increasing the number of teeth and increasing gear and pinion hardness to a range of 50 to 58 Rockwell.

		Number of Teeth	
		Old	New
1st Reduction	(Pinion	16	27
	(Gear	37	53
2nd Reduction	(Pinion	15	21
	(Gear	42	55
3rd Reduction	(Pinion	11	17
	(Gear	38	57
4th Reduction	(Pinion	15 tooth herring bone	18 tooth spur gear
	(Gear	52 tooth herring bone	65 tooth spur gear



A roller bearing which was removed from the pinion shaft that drives the herringbone gear illustrates shoulder breakage. It was caused by gear wear and end play. This condition was corrected by changing to a non-shoulder type bearing

Rotor Shaft Scored

A ten-in. diameter rotor shaft was removed from one of the "400" machines because the shaft had become badly scored causing excessive oil leakage. Approximately 95,448 tons of coal had been mined when this occurred. The scoring was caused by metal cuttings carried by the oil in the main gear case. To prevent this condition from recurring Eastern Gas is now flushing gear cases every six months. It has also found that chrome facing rotor shafts curtails wear.

Another problem concerned the use of roller bearings for the pinion

shaft that drives the herring bone gear. Shoulder breakage was being caused by gear wear and end play. This condition was corrected by changing to a non-shoulder type bearing.

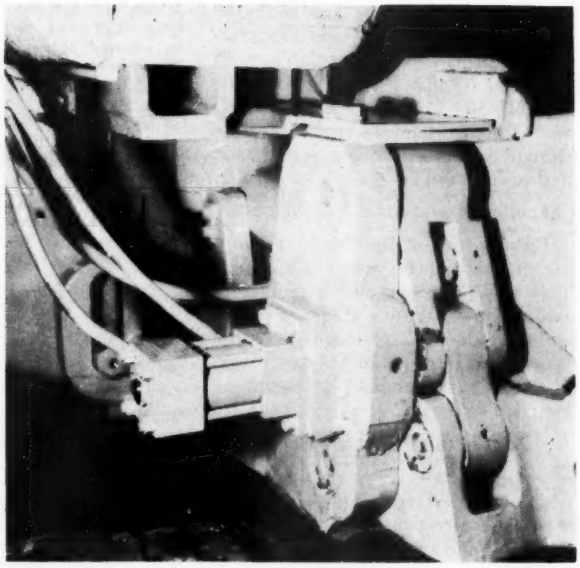
Heavier Clutch Needed

The first clutch installed on the "400" machines was located between the 100-hp bit motor and the gear case. The armature shaft was splined to the clutch shaft. The clutch pinion was splined to the drive shaft and torque was transmitted through friction discs.

This clutch was too light for the job it had to do. Friction discs galled and locked, destroying the oil film between them. To prevent this the torque was set so high that the clutch discs could not slip and operated practically as a solid shaft. Even after the torque was set so high, the clutch would burst the outer housing.

This condition brought about the replacement of the clutch and the design of what Eastern Gas calls an "adapter" shaft—an idea which was not approved by Goodman. Experience with the adapter shaft assembly showed spline wear to be excessive not only on the adapter shaft but on the pinion shaft of the bit motor. It was found that the splines on the bit motor and the adapter shaft lasted from 80 to 100 shifts.

Excessive armature shaft spline wear and high maintenance cost caused by the adapter shaft brought about the design of a new clutch. It has more discs and at least 50 percent more capacity than the old one. The armature shaft is still splined onto the clutch shaft. There have been troubles with this clutch because a failure of the clutch drive pinion requires complete disassembly of the clutch. The clutch drive pinion shaft is tapered and requires pressing into the drive hub. Goodman Manufacturing Co. has promised a change in design for easier maintenance.



Hydraulic pin puller eliminates the need for a man to remove or reset pin manually

By means of time-saving equipment, men at the Federal No. 1 mine have attached as many as 50 high pressure hose connectors in an hour

New Transmission Gear Reduction Unit

In the old type gear reducer for tramming the continuous mining machine, a small pinion shaft kept breaking, causing hours of non-productive time because of the trouble to replace it. The new transmission gear reduction unit which replaced the old one gave Eastern Gas a trouble-free unit. Primary changes incorporated the following:

The maintenance crew's "shot gun" facilitates removal of heavy pieces of equipment from continuous mining machines

(1) Larger housing
(2) Stronger gearing — designed for heavier duty
(3) Stronger shaft—designed for heavier duty
(4) Greater load capacity — increased at least 60 percent

Trim-Chain Guide and Sprocket Improvements

Originally the bottom and top trim chain guides were made in one piece, tempered to a hardness greater than 325 Brinell. This made the guides too hard and brittle, causing many failures. The coal company finally started annealing the guides, greatly extending trim chain guide life. Goodman is making the top guides in two pieces and the bottom guides in three pieces, and the hardness has been reduced to less than 250 Brinnell; maintenance has been cut 80 percent.

Other improvements include a dirt stripper or sprocket cleaner developed by Eastern Gas and a fixed left-hand corner sprocket which reduced maintenance by eliminating several moving parts plus a hydraulic cylinder. The sprocket is also set closer to the chain guide. Other devices include a hydraulic pin puller, which is used on the continuous mining machines and eliminates the need for the man to remove or reset pin manually. A bronze gear type water spray pump is mounted on the borer and driven by a hydraulic motor. The pump produces a water pressure of 100 psi. This idea was developed by the coal company's maintenance personnel.

Dual Controls Used

With the original operator control station, two levers with ball type handles or grips control the direction of the crawlers. Two break valves control the steering and metering valves control the speed of tramming. This arrangement was complicated, boiling down to three controls for each set of crawlers, resulting in more equipment to maintain. The control unit also employed a push button switch for the bit and pump motor, and steel tubing for high pressure hydraulic circuit.

The present simplified operator control station still has the two directional control valves. Steering is controlled by a lever, replacing the wheel or screw type valve with the plunger type. The rate of feed and tram is controlled by one valve instead of two. All of the machines are equipped with a new type—four position—(start, off, on and safe) switch, because a man was almost seriously injured when leads came loose, making electrical contact which started the rotor arms. The safe position of the switch provides a means of locking the machine which closes a circuit, by-passing the contactor. All steel tubing has been replaced with heavy duty Neoprene hydraulic hose. Dual controls are another feature, one that the coal company has insisted on. In fact, Eastern Gas had the first Goodman continuous mining machine equipped with complete electrical and hydraulic dual controls.

Hydraulic Equipment Experience Described

The original hydraulic steel piping arrangement was not practical for the continuous mining machine for the following reasons:

(1) It required too much time to replace the pipe and to repair leaks at joints and fittings.
(2) The rigid design caused too many maintenance "headaches" which were caused by vibration.
(3) Fine threads, no flexibility, the need for exact alignment of tube and fittings, and limited space to work in—all quickly brought about a cry from the mine's maintenance personnel for high pressure hydraulic flexible hoses and the elimination of this steel tubing.

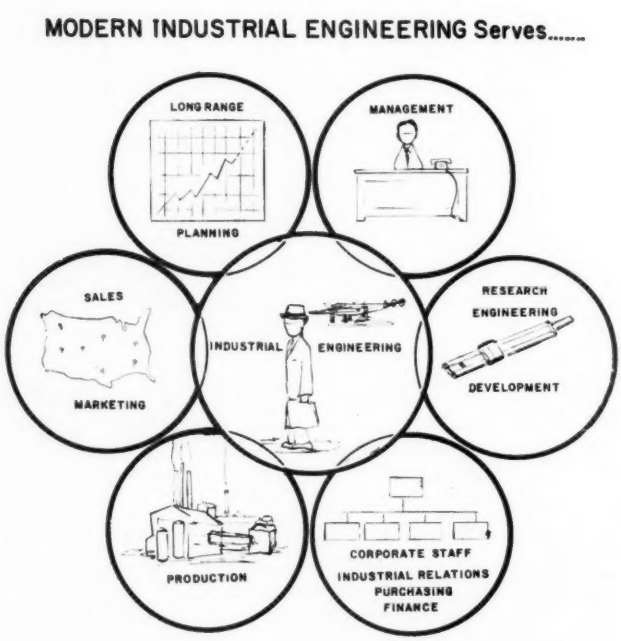
Changing to high-pressure hydraulic flexible hoses has proved advantageous. Full use of equipment is made in making up the hoses, and mine personnel have made 50 connectors or 25 complete high-pressure hydraulic hoses per hour.

"Shot Gun" Facilitates Maintenance

Removal of heavy pieces of equipment from continuous mining machines like 3100-lb 100-hp bit motors and 4000-lb 250-hp a-c motors necessitated the building of a tool that Eastern Gas calls the "shot gun." A hydraulic boom on this "shot gun" or "gismo" moves laterally and vertically by means of hydraulic cylinders. This flexibility enables company personnel to remove equipment from the continuous mining machine, load it on a shuttle car, move it to the side track, load it on a dolly and take it to the mine's inside shop.

The "shot gun" is transported on a dolly. After each job the machine is returned and placed on its transportation dolly, thereby keeping it ready to be dispatched any place in the mine on a moments notice.

Application of Industrial Engineering Principles in Mining

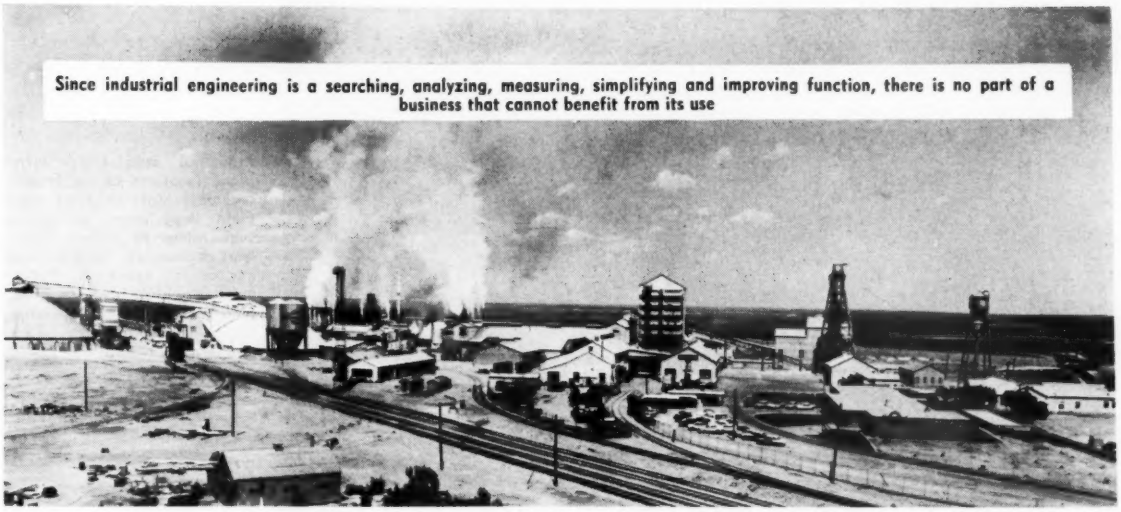


By MORLEY H. MATHEWSON
Director, Industrial Engineering
International Minerals & Chemical Corp.

TODAY'S business executives are hard pressed to find the time to meet the multitude of operating demands requiring their attention.

Decisions such as choosing one of several alternate methods of allocating resources, handling human relations, directing the attainment of sales and production goals, are only a few of the responsibilities of management. To aid in making these and many other necessary decisions, the executives of many companies are using industrial engineering staffs to work on complex business problems.

Executives in mining are confronted with the same complex problems. However, there are indications that the principles of modern industrial engineering, which are widely



Since industrial engineering is a searching, analyzing, measuring, simplifying and improving function, there is no part of a business that cannot benefit from its use

used by the most successful companies, are not well known, thoroughly understood or widely utilized in the mining industry.

While it is recognized that a few mining companies have outstanding industrial engineering organizations, the mining industry does not compare favorably with other industries in this regard.

The aim of this article is to present a clear, concise picture of the contribution industrial engineering can make to mining. As the subject is reviewed, it will be helpful to consider industrial engineering principles as "a powerful and valuable set of management tools." In practice, every successful professional manager uses industrial engineering principles as an integral part of the technique of managing.

Today the professional manager looks to industrial engineering for the research, development and control of human and material resources just as he looks to the research and development function for new and better products.

To discuss the application of industrial engineering principles in mining in its broadest ramifications, answers to the following questions will contribute to a better understanding of this subject: 1) What is industrial engineering? 2) How can it best serve the mining industry? 3) What should the mining industry expect from industrial engineering? 4) What is its role at IMC?

What Is Industrial Engineering?

The American Institute of Industrial Engineers says:

"Industrial engineering is concerned with the design, improvement, and installation of integrated systems of men, materials, and equipment; drawing upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems."

Overly simplified, the professional industrial engineer should provide assistance in reducing operating costs, increasing recoveries, improving quality of products, achieving greater control and increasing profits.

How Can It Best Serve the Mining Industry?

To be successful, industrial engineering must be recognized as a major function in the company. This is demonstrated by the fact that the most successful industrial engineering organizations today report either to the president or administrative vice president at the corporate level and to the division manager, plant head or operations manager at the plant level.

Of equal importance to the position in the organization is the enlightened understanding, backing and support given industrial engineering by management. To assure maximum success, management must take the time to become familiar with industrial engineering principles so that the attitude of cooperativeness permeates the organization. Again, in companies with the most successful industrial engineering programs, top management is personally interested in reviewing each major study.

There must always exist a clear understanding of the working relationships between line and staff. As a staff function, industrial engineering must work in a service capacity and must not impinge upon the authority of line personnel. Conversely, line must work with staff so that the full benefits from their common efforts are achieved. Maturity of management in a corporation can be accurately measured by the manner in which the line and staff groups work effectively together.

Industrial engineering must have one objective and that is to increase profit performance. Its job is to recommend programs to management and management must assume the responsibility for implementation. In this way team effort without conflict of interests produces the best results.

The scope of industrial engineering is determined by the ability of management to understand these tools and apply them to the business. Since industrial engineering is a searching, analyzing, measuring, simplifying and improving function, there is no part of a business that cannot benefit from its use.

What Should the Mining Industry Expect?

To gain the maximum benefits, the mining industry should expect industrial engineering to perform the following services:

1) Assist management in never-ending cost reduction and control programs
2) Conduct organizational studies
3) Coordinate development of corporate maintenance policies and programs
4) Formulate and recommend corpo-

Industrial engineering serves plant locations either from a corporate staff or plant staff. Field departments encompass such things as modern industrial engineering which includes operations research, better methods, maintenance planning and control, and operating controls

rate inventory policies and develop divisional inventory management procedures

5) Initiate, develop and recommend corporation equipment replacement policies
6) Assist management in long range planning
7) Develop production planning and scheduling procedures
8) Establish engineered standards of performance for management control
9) Determine and recommend the optimum usage of equipment and facilities
10) Verify economic feasibility of capital expenditure requests
11) Conduct manufacturing and office method surveys
12) Conduct facility location studies
13) Develop and install job evaluation programs
14) Identify and solve distribution problems
15) Perform functional counterpart audit
16) Furnish liaison services between division management and outside consultants
17) Provide assistance to all levels of management in solving problems requiring statistical and applied mathematical analysis
18) Assist management in decision making through the use of computers or through the development of mathematical models simulating complex business problems
19) Coordinate studies involving line and staff functions crossing divisional lines
20) Assist management in formulating and developing corporate policies and procedures
21) Develop and recommend quality control programs

In addition to the above, industrial engineering should work closely with the following functions:

Top Management. Assist management in decision-making through the use of computers or the development of mathematical and statistical models simulating complex business problems.

Finance. Develop the standards used to control labor, materials and expenses. The finance function should use this data to establish standard costs and budgets.

Human Relations. Keep industrial and public relations informed on matters that affect human relations. Matters pertaining to training, incentive compensation, working conditions or organizational studies should be coordinated.

Purchasing. Provide assistance in evaluating optimum material specifications, establishing economic order quantities and order points, and developing methods and procedures to provide best service for least cost.

Transportation. Provide assistance in evaluating alternative distribution patterns to determine the optimum plan to meet customer requirements, particularly where advanced techniques are feasible.

Engineering. Work with engineering to see that human engineering and work simplification concepts are followed in machinery design, placement, usage and standardization of replacement parts.

Maintenance. Work closely with maintenance management to design systems, procedures and techniques to reduce maintenance costs.

Production and Quality Control. Provide assistance to achieve maximum utilization of equipment, materials, tools and products to achieve optimum cost performance.

Its Role at IMC

In order to understand the role of industrial engineering at International Minerals & Chemical Corp., it is necessary to have an understanding of the organization and the way it functions.

Thomas M. Ware, president and chief executive officer of IMC, is a recognized leader in the field of industrial engineering and operations research. Many years ago he realized the value of this type of internal consulting service and organized this function in the corporation.

IMC is organized on a divisional line and staff basis. Both segments of the organization play prominent roles and have clearly defined responsibilities in contributing to the successful performance of the company.

The operating divisions consist of Agricultural Chemicals, Plant Food, Amino Products, Industrial Minerals and Overseas Operations. The president delegates to the operating divisions the responsibility for administration—planning and execution of programs.

The central staff divisions consist of Long Range Planning, Finance, Marketing, Research-Engineering-Development, and Administrative Services. The staff functions have the basic responsibility of assisting the president in planning, coordinating and controlling the company's operations. Central staff also provides services and expert guidance to the operating divisions.

Company Operates 72 Plants

A brief review of the company's operations shows 72 plants located throughout the United States, Canada and Mexico producing some 57 different products. Nineteen non-metallic minerals are mined and used as beneficiated or as changed through chemical processing operations. IMC has extensive mining operations—for phosphate in Florida and for potash in New Mexico. We also have a multi-million dollar potash mining operation under construction in Canada. In addition to these major operations, the corporation has many other mining and chemical operations throughout the United States, Canada and Mexico.

With this brief background information, we are now in a position to review the unique role of industrial engineering at IMC which is due to two basic facts: 1) Our management has a keen appreciation and awareness of the importance of scientific management and the need for innovation; and 2) Our type of industry, which is heavily oriented in mining, has pioneered in automation. This is natural because of the volume of products that are handled which entails the development of materials handling and continuous flow systems.

Because of the type of business we are in (mining and chemical) and because of our management viewpoint, industrial engineering and operations research is constantly broadening its viewpoint to give consideration to the whole. Emphasis is placed on the basic principles of using scientific analysis as a means of finding improvements. To quote our president, "The Industrial Engineer finds himself leaning more towards teaming with others and stressing the scientific, the economic and management side of things."

This is the new challenge facing the industrial engineer of today, and it demands that he be much more than what has been traditionally accepted in the past.

In following this kind of thinking it means that the industrial engineer must be much more broadly trained in his ability to perceive problem situations, and to use conceptual strategy drawing broadly from engineering skills, economic skills and management skills.

Five Concepts Characterize Management Thinking

Management philosophy has played an important part in the role of industrial engineering at IMC. Starting in 1959, five decades of experience have contributed to management's thinking in major areas of control. The concepts which have evolved over the years are categorized as follows:

1) **Management Control Concept.** Management will apply scientific principles of management and control wherever possible.

2) **Segregation of Planning from Performance Principle.** To facilitate establishing performance standards management will be responsible for the separation of planning from production.

3) **Scientific Method of Work Principle.** Management is responsible for determining the best method of performing a task and it shall train the workers in these methods.

4) **Work Measurement Principle.** Work will be accurately measured with the ultimate objective to establish standards of performance.

5) **Incentive Compensation Principle.** Incentive compensation will be paid for measured performance above standard.

Organization of I.E. Department

From an organizational viewpoint, International's Industrial Engineering Department is headed by the director of industrial engineering who reports to the administrative vice president. The department is divided into two sections consisting of internal consultants in industrial engineering and in operations research. The same organizational pattern is followed at the plant level with the staff manager of industrial engineering reporting to the operations manager.

Industrial Engineering Section

Some of the responsibilities of the industrial engineering section are:

1) To interest all levels of management in the development and installation of well-integrated industrial engineering

Some of the tools and techniques used in industrial engineering and operations research:

1) Problem Definition
2) Organization Analysis
3) Management Controls
4) Scientific Analysis
5) System Analysis
6) Engineering Economics
7) System Simulation
8) Human Engineering
9) Report Writing
10) Questioning Attitude
11) Personnel Analysis
12) Cost Analysis
13) Creative Thinking
14) Quality Analysis
15) Motivation
16) Team Approach
17) Sensitivity
18) Work Sampling
19) Computer Application
20) Work Sampling
21) Mathematical Model
22) Communication Theory
23) Decision Theory
24) Analytical Graphs
25) Control Charts
26) Model Building
27) Objectivity
28) Value Analysis
29) Multi-Product Analysis
30) Budget Analysis
31) Flow Process Charts
32) Man & Machine Charts
33) Plant Layout
34) Material Analysis
35) Operation Process Chart
36) Plant Site Analysis
37) Gantt Chart
38) Production Analysis
39) Materials Handling
40) Simo-Chart
41) Time Study
42) Job Analysis & Evaluation
43) Mathematical Programming
44) Accounting Approach
45) Inventory Control
46) Nomographs
47) Profit Analysis
48) Break Even Analysis
49) Standard Data
50) Product Analysis
51) Demand Theory
52) Pre-determined Times
53) Demand Analysis
54) Motion Pictures
55) Game Theory
56) Queueing Theory
57) Form Analysis
58) Organization Planning
59) Memo-Motion
60) Variance Analysis
61) Scale Model
62) Search Theory
63) Reports Analysis
64) Graphic Chart Presentation
65) Micro-Motion
66) Data Analysis
67) Profit Measurement
68) Probability Theory
69) Monte Carlo
70) Simple & Multiple Correlation

programs to reduce costs and improve profits.

2) To coordinate divisional industrial engineering activities.
3) To establish uniform practices, policies and techniques.
4) To assist all levels of management on problems requiring statistical correlation techniques or mathematical programming.
5) To communicate ideas and results of integrated system approach into clear, concise conclusions.
6) To develop new concepts and introduce new methods of analysis to be used in problem solving.
7) To direct programs requiring the development of models and measures of efficiency needed in business analysis and planning.
8) To provide sound basis for arriving at an integrated and objective analyses of operating problems.
9) To work with management to develop sound forecasting and trending of business operations through the use of multiple correlation techniques.
10) To assist in organization planning, through analysis evaluation of interactions and relationships of functions and personnel to develop objectives and human resources needed to achieve company goals.
11) To assist management and provide service in directing integrated systems studies of problems in the following areas: a) organization planning, b) economic control of manufacture, c) incentive programming, d) maintenance programming, e) optimum usage of equipment, f) plant and warehouse location studies, g) materials handling, h) inventory control, i) cost programming, j) production control and k) distribution audits.

Operations Research

Some of the responsibilities of the operations research section are:

1) To provide internal consulting service in problem solving, utilizing simple or multiple correlation or mathematical programming.
2) To organize specialized groups to study problems requiring the use of mathematics, statistics and the physical and social sciences.
3) To advance the usage of computing equipment to assist management in solving plant operating and management problems.
4) To provide service and promote the use of such techniques as probability theory, queueing theory, game theory, Monte Carlo and sampling methods to improve process or plant performance.
5) To direct team assignments cutting across divisional lines to utilize varied skills, techniques and knowledge of individuals and disciplines in problem solving.
6) To provide service in constructing conceptual, mathematical or physical models to portray relationships or interactions of the components to the whole.
7) To provide service and promote the use of system simulation by developing conceptual models concerned with the interaction of elements in a process which simulates real problems.
8) To provide service and promote the use of system analysis approach to improve performance and reduce costs by comprehensive analysis of interactions of human, physical and psychological elements in process or operation.

In closing, it should again be emphasized that a few mining companies have outstanding industrial engineering organizations. By comparison, however, a great majority of the mining companies are not acquainted with the principles of modern industrial engineering.

There isn't any question that the mining industry can greatly benefit from the application of these modern tools. The only limiting factor appears to be the industrial engineering managers' ability to do the job and sell these concepts and management's willingness to take the time to understand and apply these principles to every facet of the business.

Resist or Yield . . . *WHICH IS BETTER WHEN THE PRESSURE'S ON?*

In heavy or shifting ground, a mine opening always needs some form of support to give the overburden a chance to settle naturally into a pressure arch. Mining men have found that the best type of support is one which will yield slowly to the pressures until the natural arch is formed; rigid sets simply cannot resist the dynamic forces indefinitely.

Holds Fast Under Normal Loads

Bethlehem's Yieldable Arch is just the kind of support you need in squeezing pressures. Each set of arches works on a principle of sliding joints, which are formed by the lapping of one U-shaped segmental steel section over another as shown in the photograph. Husky U-bolt clamps are installed in pairs over the lapped joints, and drawn up tightly enough to hold fast under normal loads. As pressures bear down, however, the set yields, a little at a time.

Adds to Mine Safety

As the Yieldable Arch "gives," the stress is transferred to the surrounding material. When equilibrium is reached the Yieldable Arch stands pat, its structural integrity maintained and mine safety preserved. That is why you will hear it said that the yieldability of the Arch is more important than physical strength.

There is much more you will want to know about the Yieldable Arch. Its ease of installation, for example, and its high degree of recoverability. You'll be interested, too, in knowing that many Yieldable Arch installations have paid for themselves in a matter of months! A Bethlehem engineer will be glad to discuss the full story in terms of your own special conditions. Just give us a call.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corp.

BETHLEHEM STEEL

BETHLEHEM STEEL

Twenty-eight mine fires occurred in northern West Virginia during the period 1949-1958. What caused these fires and what methods were employed in fighting them?

MINE FIRES in

By WILLIAM O. BARNARD, JR.

General Superintendent
Christopher Coal Co.

IN a review of mine fires in northern West Virginia, as reported by the U. S. Bureau of Mines in the last ten years, it is found that the number of mine fires by years is as shown in Table I.

Table I. Mine fires in northern West Virginia

Year	*No. of fires*
1949	0
1950	2
1951	1
1952	1
1953	0
1954	5
1955	4
1956	3
1957	8
1958	4
Total 10	28

A further study of these mine fires reveals a total of 28 fires in ten years for an average of nearly three per year (2.8 actual). A better look shows that the safety record is getting worse as 24 of the fires have occurred in the last five years. This is a rate of nearly five per year.

Table II provides an itemized account of fires by years, showing in which seams the fires occurred and also a brief description of the cause of fire, if fire was fought by direct methods, what materials were used in fighting the fire and the results accomplished.

In analyzing table II, the mine fires can be broken down into five general groups. The biggest cause of

Table II. Fires in northern West Virginia (1949–1958)

Fire No.	Coal Seam	Cause of Fire	Fought Direct	Materials Used	Results
50-1	Pittsburgh	Roof fall on power wires	Yes	Water lines with 10-hr delay	Sealed
50-2	Pittsburgh	Old gob line	No		Sealed
51-1	Pittsburgh	Fall on trolley wire	Yes	Water and rock dust	Sealed
52-1	Pittsburgh	Outcrop fire	Yes	Water and digging	Extinguished
54-1	Pittsburgh	Fall on trolley	Yes	Water and rock dust	Sealed
54-2	Redstone	Short circuit on cutter	Yes	Fire extinguisher and rock dust	Sealed
54-3	Bakerstown	Short circuit on cutter	Yes	Water	Extinguished
54-4	Pittsburgh	Belt fire	Yes	Water	Extinguished
54-5	Pittsburgh	Sparks in supply car	Yes	Fire extinguishers, rock dust and water	Sealed
55-1	Sewell	Short circuit on shuttle car	Yes	Water and fire extinguisher	Extinguished
55-2	Pittsburgh	Belt fire	Yes	Water	Sealed
55-3	Sewell	Belt fire	Yes	Water and fire extinguisher	Extinguished
55-4	Pittsburgh	Short circuit on cutter	Yes	Water, rock dust and fire extinguisher	Extinguished
56-1	Pittsburgh	Fall on trolley wire	Yes	Fire truck and rock dust	Extinguished
56-2	Pittsburgh	Old gob line	No		Sealed
56-3	Pittsburgh	Short circuit on loader	Yes	Rock dust and water	Extinguished
57-1	Pittsburgh	Short circuit on loader	No		Sealed
57-2	Pittsburgh	Derailment in mainline haulage	Yes	Fire extinguishers, water and rock dust	Extinguished
57-3	Pittsburgh	Fall on trolley wire	Yes	Fire extinguishers, rock dust and water	Extinguished
57-4	Pittsburgh	Short circuit on cutter	Yes	Fire truck, water and rock dust	Extinguished
57-5	Sewickley	Fall of trolley wire	Yes	Fire extinguishers, rock dust and water	Extinguished
57-6	Pittsburgh	Short circuit on trolley phone	Yes	Water and rock dust	Sealed
57-7	Pittsburgh	Fall on feeder wire	Yes	Water and fire extinguishers	Extinguished
57-8	Pittsburgh	Short circuit on continuous mining machine	Yes	Fire extinguishers, rock dust and water	Sealed
58-1	Pittsburgh	Short circuit on cutter	Yes	Extinguisher and rock dust	Sealed
58-2	Upper Freeport	Short circuit on cutter	Yes	Fire extinguisher and rock dust	Extinguished
58-3	Pittsburgh	Short circuit on cutter	Yes	Water	Sealed
58-4	Pittsburgh	Belt fire	Yes	Rock dust, water and fire extinguishers	Sealed

NORTHERN WEST VIRGINIA

mine fires was by *electrical short circuit on equipment*, which caused 12 fires or 43 percent of the total number of fires. Next largest class is that of *falls on power lines* which accounted for seven fires or 25 percent. In the next group, *belt fires*, there are four, or 14 percent, and three of the mine fires concerned *gob lines or outcrop* fires. The last general classification was that of *haulage* in which there were two fires.

A look at the results in fighting these fires shows 15 were extinguished by direct means and 13 had to be sealed.

Table II also shows that all but six of the fires occurred in the Pittsburgh seam of coal. Let us examine these fires in the Pittsburgh seam further. In mining this seam, generally 6 to 12 in. of head coal is left. This is done to protect the draw slate immediately above the coal which loses its strength when exposed to air. The main roof is laminated shale and sandstone. In the analysis of mine fires, head coal is found to have great effect on mine fires in the Pittsburgh seam. The period of time to combat a mine fire is very limited due to the heat, which causes the head coal to fall and feed the fire. First, small pieces of head coal fall and gradually cause a weakening of the roof. Bigger falls bring the head coal in direct contact with the fire area. It is felt that head coal definitely shortens the period of time to combat a fire successfully.

Use of roof bolts has helped in fighting fires in that wooden timbers themselves often caught fire and burned very readily, causing falls.

A Specific Fire

Let us examine one mine fire in the Pittsburgh seam in particular. This fire occurred in August 1957, on an idle day. The fire apparently was caused by a short circuit of a power line to a trolley phone used on the section. The fire had about two hours head start before it was discovered by a pumper. This was a slow burning, smoldering fire. Because trips of coal were parked in two of the intakes, much of the intake air traveled up the middle heading and the fire was confined to this middle heading outby the loading point. The fire burned outward about 2000 ft from the originating point and the air current did not penetrate the heat block created by the fire, as the rock dust in returns was not discolored. Sealing was accomplished by erecting six concrete block seals and using 22 stoppings that were in place. In 48 hours a sample behind the seal showed that oxygen was down to two percent and remaining areas of the mine resumed operations.

About four months later the seals were opened and no fire was present. Figure 1 shows some of the damage from the fire and figure 2 shows one of the falls in the area. Because roof conditions in this fire area had been considered very good before the fire. the decision was made to go ahead and extract the pillars. During pillaring operations, however, heat cracks were found to extend six to ten ft above the roof line, causing hazardous mining conditions.

Combating Fire Directly

The most important phase of mine fires of course is "Fire Prevention." Nothing is as important as preventing fire. Of course it must be assumed that some fires will happen no matter how good a job of fire prevention is done; therefore, there must be fire control. It can be divided into two classes:

(1) Direct—combating fire directly with water or other extinguishing agents.
(2) Indirect—method of sealing fire so that it will die from lack of oxygen or by flooding the fire area.

Fig. 1. Extensive coking was caused by a mine fire. In some areas the coking extended from roof to floor

Fig. 2. Although heat has melted plates off the roof bolts, it did not disturb anchorage

Of course the direct method is nearly always attempted first. The big factors in this method are:

(1) Time
(2) Material to extinguish fire
(3) Training of men to fight fire

Let us take a look at these elements of direct fighting of a mine fire.

Time. Authorities agree that most fires can be extinguished if attacked early. Every minute counts. All fires are small in their incipient stage and every minute lost makes the job tougher. But this time element must be closely associated with materials to extinguish fires, because getting there rapidly with no material to put out a fire would be foolish.

Material to extinguish fires. Materials used in fighting mine fires are:

(1) Fire extinguishers
  (a) Dry type
  (b) Wet type
(2) Water
  (a) Main water supply lines
  (b) Water cars
(3) Rock dust or similar material to smother fire

In the Pittsburgh seam in northern West Virginia, most mines have nearly all the materials listed above available to combat fires. Remembering that time to get materials is very important, fire extinguishers are carried on all sections and at other key points throughout the mine. These are generally dry CO_2 type. A 150-lb CO_2 type is carried on each section and several 20-lb CO_2 extinguishers at loading points. Some mines carry a small extinguisher on each piece of equipment while many others carry bags of rock dust on the equipment to combat fires.

Most mines carry pressure water lines to all sections to allay dust in their mining operations, and these serve to combat mine fires. Most companies in northern West Virginia have a system to periodically check the water pressure throughout the mine. Also, outlets must be provided in the pressure line at regular intervals that permit hoses to overlap all possible points of ignition. In review of fires over the last ten years, a very common fault in combating fires is the lack of good water pressure. Also, water cars with pressure pumps, hose, fire fighting tools, etc., are kept at key points throughout all of the mines. Nearly all car manufacturers make a type of fire car.

An adequate supply of rock dust should be kept throughout the mine. The use of high pressure rock dusters is one of our best methods of fighting fires. Mine Safety Appliances Co. has been experimenting with the use of a mixture of sodium bicarbonate in rock dusters to fight fires. They have been successful in packaging sodium bicarbonate so that it can be stored underground without drawing moisture and this makes the bantam and high pressure rock dusters very good fire fighting equipment.

The first two elements of fire fighting—time and material—is of little value without the third.

Training of men to fight fire. In reviewing the mine fires in northern West Virginia, it was found that the fires that have been extinguished were the result of good *direct positive action* by men. The results of training in fighting fires at these mines have shown definite results. This training was started by practicing crews on fire fighting, then a gradual step-up in this training with surprise smoke bombs and the grading of crew reaction. These fire drills were developed with a competitive spirit among crews. Fire drills were extended from sections to other parts of the mine until all areas were covered.

Indirect Method—Sealing or Flooding

The coal companies in northern West Virginia realize also that not all fires can be extinguished successfully and it might be necessary to use an indirect method—either that of sealing or flooding. Each of the mines has a special map with areas for sealing marked so that all areas of the mine are covered. At all of these sealing points, the materials necessary for seals are stored. The actual seals are started in some of the main sealing points. The points at which different areas must be sealed are constantly reviewed by mine management to keep up with rapid advancing of working areas, and these sealing points are checked by safety inspectors to make sure that concrete blocks, rock dust, sand and water are available at all times.

Each of the mines has a trained mine rescue team that practices monthly. Each mine is equipped with McCaa oxygen apparatus, Chemox oxygen breathing apparatus and self-service gas masks which are kept inside and outside the mine. Self-rescuers are provided on all sections and at key points throughout the mine.

In conclusion, every effort to *prevent mine fires* must be made, but if there is a mine fire the company must be prepared to fight fire directly at its earliest stage with material that is readily available and with men that are trained to take positive direct action. If all else fails, the company must have definite plans ahead for sealing or flooding mine fires in all areas of the mine to safeguard both life and property.

BENCH MINING SALT on the GULF COAST

By WAYNE WEST
Assistant Manager
Weeks Island Mine
Morton Salt Co.

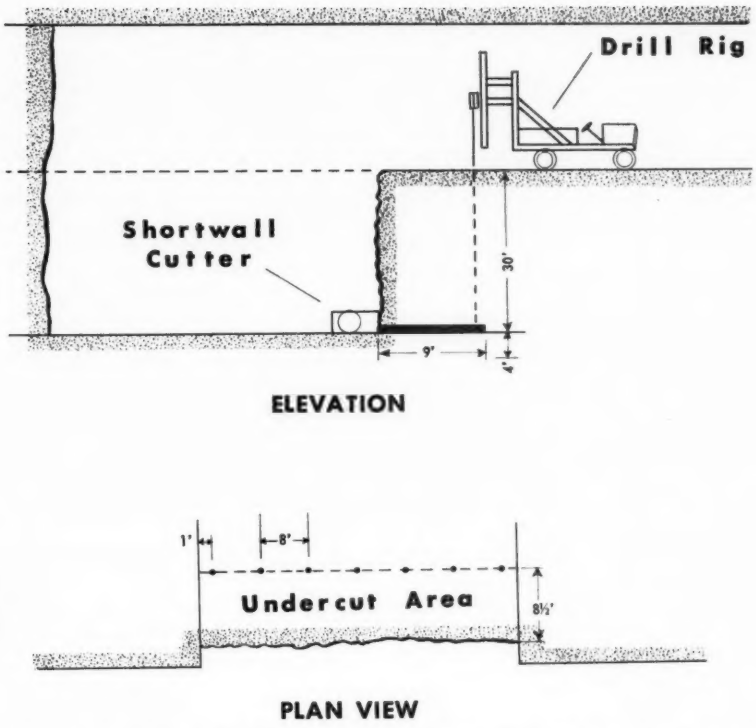
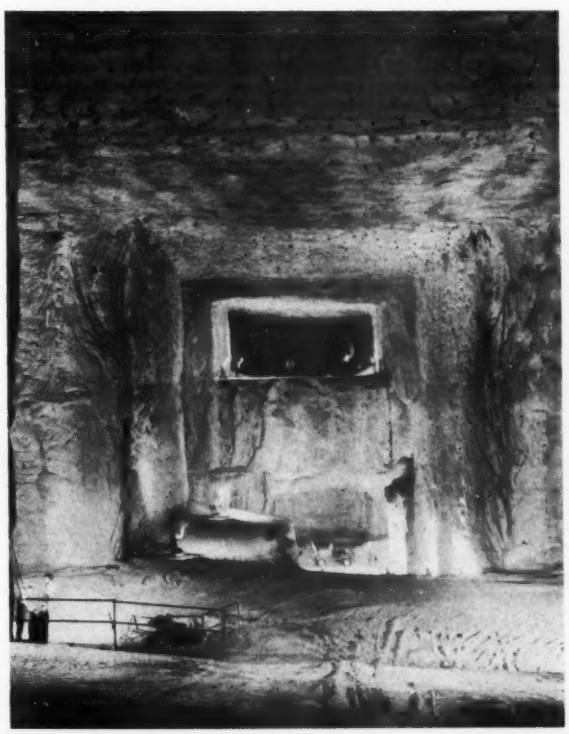


Fig. 1. Undercutting and positioning of vertical holes are illustrated in these views of the benching procedure

Compared with conventional face drilling, benching has reduced labor cost 50 percent and lowered powder and cap cost 40 percent—at the same time, it has provided better breakage

MINING operations of the Morton Salt Co. at Weeks Island, La., are in one of the massive salt domes that are found along this portion of our Gulf Coast. This dome is actually a giant column of salt, more than 2½ miles across in some directions, and extending to a known depth of 22,000 ft. Present production is from the 50-ft level. Development on this level was expanded three years ago with the sinking of a second shaft. From the shaft, rooms were driven 50 ft wide and 25 ft high, leaving 100-ft pillars.

Originally, an additional 50 to 65 ft was taken from the roof by back stoping. This method, however, created several problems. Scaling top, for example, was especially troublesome in the 75 to 90 ft high rooms.



General view of main entry showing shuttle car dump pocket in lower left

Late in 1957, it was decided to begin benching down 30 ft.

Benching Method Vast Improvement

This benching method has proved extremely successful and has effected substantial savings over previous production methods. Compared with the conventional face drilling system, benching has reduced labor cost by 50 percent and lowered powder and cap cost 40 percent per ton of salt, while at the same time providing better breakage. Table 1 shows a comparison of the two methods.

Table 1. Comparison of benching method and face drilling method to produce a 900-ton round

Method	No. of Blast Holes	Depth of Holes	Total Footage Drilled	Powder (lbs.)	Blasting Caps Used
Face Drilling—horizontal	120	10′	1200′	350	120
Bench Drilling—vertical down	7	34′	238′	200	7

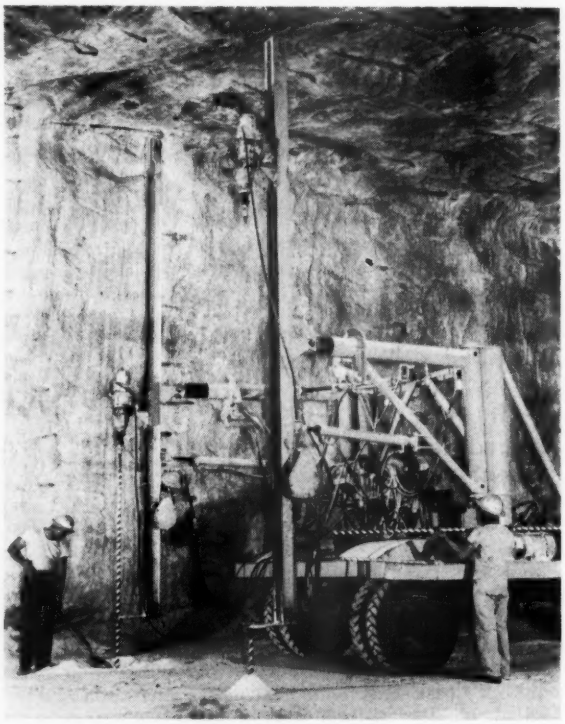
The benching procedure is illustrated in figure 1. A 50-ft wide bench is prepared by drilling a row of seven holes 8½ ft back from the crest or face of the bench. These holes are drilled vertically down to a depth of 34 ft which allows four ft to collect cuttings not cleaned out of the hole. Two Jeffrey A6 drills are used on the mobile, truck-mounted rig designed by Landis Steel Co. Two hydraulically controlled booms position the 18-ft chain sashes. Kennametal two-in. drill bits are used with Kennametal threaded sectional augers. Three 12-ft sections of 1¾ in. diam auger are used on each drill, and with a penetration rate of ten fpm, it is easy for the drillers to keep well ahead of the cutter operator and shot firers. With this rig, operators drill 35 or 37 holes, or a little more than five places per shift. Preparing the bench requires less than one-fifth the drilling footage needed by the previous method.

After the place is drilled, it is undercut with a Joy 7B shortwall cutter. The nine-ft bar on this machine cuts through the seven vertical holes. This clears the holes of any remaining cuttings and does not interfere with charging them. A seven-position chain lacing and Kennametal U10S cutter bits cut a six-in. kerf. It takes approximately 2½ hours to sump in and complete the 50-ft undercut. This cut is not necessary to obtain breakage, but it is made to maintain a smooth floor for the mobile equipment. When the holes are charged with 60 percent strength semi-gelatin explosives and fired with electric-blasting caps, about 900 tons of salt are broken down ready for loading—little secondary blasting is required. A typical bench shot produced 875 tons of salt with 186 lb of explosive.

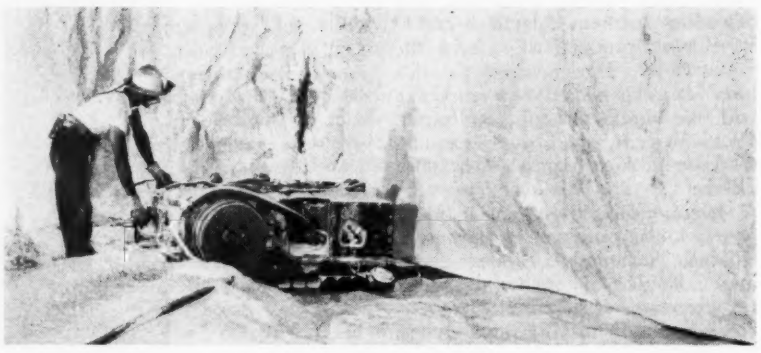
Underground Haulage and Sizing

The broken salt is loaded into ten-ton shuttle cars by Joy 18HR loaders. Of the five shuttle cars in use, two are diesel-electric and three are straight battery powered. The company plans to convert all of them to diesel-electric. These cars dump onto a grizzley with oversize going through a 36 in. by 36 in. Jeffrey single roll crusher which breaks it down to minus 1¾ in. From this pocket, an inclined 36 in. belt carries the salt to Allis-Chalmers scalping screens which send everything over 1⅛ in. through a two-roll mill. All minus 1⅛-in. salt is carried by belt to a skip loading pocket.

An automatic weighing device loads the twin, six-ton aluminum skips. A double drum Vulcan hoist, powered by a 500-hp induction motor, brings the skips to the surface where they dump into a 100-ton bin. The complete hoisting cycle, loading and dumping two skips, takes 140 sec. Mine run salt for bulk shipment is taken from this bin, at the head frame, to the barge loading dock by trucks. The remainder is carried a distance of approximately 900 ft to the mill on 30 in. belts.



Drill rig (right) in operation showing one operator clearing cuttings from the top of the hole while the other operator prepares to add a section of auger



Cutter (below) operator is nearing the end of a nine ft deep undercut across a 50 ft wide face

COAL RESEARCH

PART II

The second and final portion of the report on Coal Research in 1959 reviews the work of a number of major research centers outside of the United States. A study of Part II will not only give readers a better perspective of foreign coal research but will illustrate the community of interest in the world-wide coal picture

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and

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IN reporting on coal research abroad, it was thought more useful to the reader to organize the following brief summaries by country and institution.

Canada

Department of Mines and Technical Surveys, Mines Branch, Fuels Division—Ottawa, Ontario. Research in Canada is being carried on to improve the technology of production and utilization of coal.

In mining research, theoretical and experimental analyses of the ground stresses associated with particular mining operations have been made. A uniaxial stressmeter together with a recording apparatus have been developed to measure the stress changes that occur in the interior of an ore body. Associated activities in mining research included determination of absolute stress values; development of a time-strain apparatus load maintenance unit and a compressometer; studies of shear, bending strengths and jet piercing of rocks; together with studies on the strength of coal and on mine dusts.

Preparation activities covered coal storage, size distribution, surveys on cleaning and washing methods for lump and fine coals, briqueting of fines, a physical and chemical survey of Canadian coals which includes the relationship of petrographic constitution to the coking properties of bituminous coal.

Work on the briquetting of coal fines for sized fuel indicates that satisfactory industrial type briquettes can be produced with as little as four percent asphalt. Work was also done on binderless briquetting tests, using high pressure roll presses.

Carbonization research activities have dealt primarily with the assessment of Canadian coking coals for their use in the production of metallurgical and industrial cokes and with the testing of coals of foreign origin. Work is currently under way to produce a high fixed carbon product prepared from Alberta coals which would be acceptable as a reductant in the phosphorus industry.

In the Division of Gasification, current work deals with the study of the stress relief phenomena in coal mines with "outbursts" of gas and coal receiving particular attention. The outbursting of coal has been attributed to (1) gas content, (2) coal structure, (3) rock pressure (virgin stress and stress from mining).

Research Council of Alberta—Edmonton, Alberta. Alberta's coal reserves amount to half of all the coal present in Canada. Major research is on various aspects of coal carbonization, the properties of humic acids and related substances, and work on coal combustion. In addition, smaller programs of geological survey and paleobotanical work are under way.

Laboratory studies continue on coal carbonization and the mechanism of coal pyrolysis. Paralleling the laboratory studies, several tests have been conducted in a fluidized coal carbonization pilot plant, supplemented by small-scale investigations and carbonization assays.

Under investigation is the constitution and structure of coal, humic acids and simple derivatives, and the bacteriological oxidation of aromatic hydrocarbons. The efficacy of oxidized coal slack and of humic acids as a soil amendment and as a drilling mud additive is being studied.

Further geological surveys have

been undertaken in search of reserves capable of being won by strip mining. There has been limited geological exploration, especially for high-grade coking coal, in Alberta's Rocky Mountain chain, and an ecological study of a major Alberta coal zone.

Great Britain

National Coal Board—London, England. Research on the mining of coal and on certain aspects of its preparation and use is carried out by the National Coal Board in its own Coal Research and Mining Research Establishments. A number of smaller discrete investigations are sponsored by the Board in university departments and in other research laboratories, and, in addition, the British Coal Utilisation Research Association, the British Coke Research Association, and the Coal Tar Research Association, with support from the National Coal Board, carry out their own appropriate research programs.

At the Mining Research Establishment, the basic problems of coal extraction and its transport to the surface are studied. Studies on the mechanical properties of coal and rock have shown that the strength of saturated rock specimen was 45 percent of that of completely dry rock. Variations with petrographic composition are now being measured. Studies on the effect of speed of coal cutter picks have shown that cutting force is almost independent of speed over the range of 50 to 600 fpm. Improvements have been made in coal sensing devices, and a sensing head has been developed for use on the Midget Miner. In studies of long-hole percussive drilling for methane drainage, additional evidence has been found that penetration rate depends on the total energy applied, irrespective of whether it is achieved by many light blows or few heavy ones. Shaft sinking, strata control, transport, ventilation, methane and dust control are other activities which have been studied.

The Coal Research Establishment is concerned primarily with the upgrading of coals in size and quality, and especially with the preparation of smokeless fuels. Work on coal cleaning, and dewatering of coal slurries in an extrusion press to produce compressed blocks has continued. The current program is directed to the production of lump from fine coal and several approaches to this end have made progress.

The British Coke Research Association—London, England. The year 1959 was the first full year at the new Coke Research Centre at Chesterfield in Derbyshire. The Association had maintained a number of laboratories at different places; now virtually all the activities are concentrated at one site.

A unique feature of the Coke Research Centre is the 10-ton capacity test oven plant which provides facilities for carrying out carbonization tests under research conditions but on a scale directly comparable with commercial practice. Tests this year were made to establish reproducibility levels, and to study the effects of altering the bulk density of the charge and the rate of carbonization, together with variations in benzol produced.

Other activities deal with the use of additives on reactivity of coke for domestic use; the strength, structure and mechanical properties of coke; the resistance of beds of coke to the flow of gases, and liquid and gaseous effluents from coke plants.

On the assessment of the strength of coke, it has been found that there is good correlation between the M_{40} Micum index and the $1\frac{1}{2}$-in. shatter for a wide range of cokes.

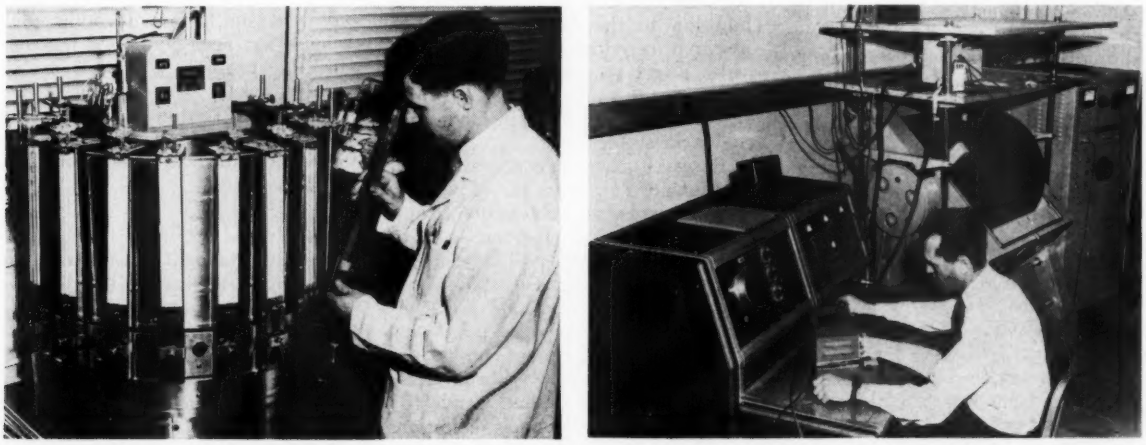
Fundamental work on the structure of coke in relation to the chemical and physical properties was made, investigating the parts played by oxygen, sulfur, and nitrogen. Special techniques such as measurements of the magnetic properties of cokes and carbons are being used.

Northern Coke Research Laboratory, King's College, University of Durham—Newcastle-on-Tyne, England. This laboratory is concerned with the fundamental study of the problems of carbonization and is supported by the British Coke Research Association. In recent years, it has been concerned with a study of the process of carbonization and the properties of carbons.

Single crystals of vat dyes were used as models to study the mechanism of crystallite formation during coking.

The surface characteristics and pore dimensions of a large variety of carbons have been evaluated from a study of the sorption of gases. Magnetic studies of these carbons have shown the rapid developments of diamagnetism during the process of carbonization and have also revealed an initial development of paramagnetism at temperatures between 500 and 700°C.

Reactivity of carbon toward carbon dioxide and oxygen has been shown to be markedly dependent on



Modern equipment at the Research Council of Alberta includes a Warburg Respirometer (left), employed in microbiological studies of coal, and an electron paramagnetic resonance spectrometer (right). Major research is devoted to various aspects of coal carbonization, properties of humic acids and related substances, and coal combustion

A unique feature of the Coke Research Centre of the British Coal Research Association is the ten-ton capacity test oven which provides facilities for carrying out carbonization tests under research conditions but on a scale directly comparable with commercial practice

the presence of impurities. The importance of alkali-metal salts in catalyzing these reactions has been studied over a range of temperatures and it has been shown that these salts markedly decrease the stability of surface oxides.

University of Leeds, Department of Mining—Leeds, England. Research is in the following areas: pneumatic transport, pneumatic stowage, geophysical surveying, ground movement and strata control, ventilation, mineral dressing and coal preparation.

Leeds is working on the dewatering of fine coal. Other research projects include: the kinetics of the flotation process; a study of flotation cell design; measurement of induction times for bubble-mineral adhesion; the conditioning of fine coal for froth flotation, including the sorption of flotation reagents on coal; a study of residence times in flotation circuits; micromeretics in coal preparation; fundamental studies of water concentration processes; and analysis of unit processes and filtration through micro-porous membranes.

Department of Scientific and Industrial Research, Warren Spring Laboratory — Stevenage, Hertfordshire, England. Work is being done on the Fischer-Tropsch synthesis of oils and chemicals from coal. The objective of the current program is to perfect the development of the liquid-phase or "slurry" type of synthesis process in which the catalyst is dispersed in a liquid medium through which the synthesis gas is passed. Work was done on the development of an iron catalyst; effects of H_2/CO ratio and CO_2 content on rate of synthesis reaction; operation of a 2000–3000 cu ft per hr synthesis pilot plant; and factors affecting the activity and life of catalysts.

France

Centre d'Etudes et Recherches des Charbonnages de France — Paris, France. The work of CERCHAR is carried on in the laboratory at Verneuil and in its semi-industrial permanent stations at Meurchin and Marienau as well as in the mines. In addition to the Centre's immediate research activities, CERCHAR provides direct service to the mines in following through on its previous research projects, both in laboratory and field studies.

Research program concerning mining included projects on (1) safety (use of explosives, detonation, transmission, delayed firing, emission of methane, propagation of dust explosions, a device to prevent short circuits, and a rapid gas analyzer), (2) silicosis (evolution of experimental silicosis, mechanisms of pulmonary purification, action of substances to slow or stop evolution) and (3) equipment and mining conditions (underground communications, ground pressures, design and wear of mining machine cutter teeth).

In the field of coal preparation and treatment, process improvement studies in coal cleaning, especially where treatment involves fine coal, have been major activities. Better selection of flotation reagents has resulted in important economies in yield and circuit simplification. Activities in briquetting have been aimed at decreased use of pitch. Equipment for achieving better regulation of pitch addition, mixing and blending has been developed. Because the usual binders (pitch and bitumen) tend to emit smoke on combustion, work on a smokeless substitute binder has gone forward.

A pilot unit to manufacture coke by fluidization has been developed and work on factors affecting coke strength has been continued together with the problem of reactivity of foundry coke.

Theoretical studies as well as pilot furnace tests have been made on the combustion of briquettes and powdered coal.

Belgium

Institut National de l'Industrie Charbonniere—Liege. INICHAR is a government establishment doing scientific research for the Belgian coal industry. Its coal research activities have dealt with mining, preparation, by-products, up-grading and utilization.

Activities in mining are in the formation of coal deposits, driving of stone drifts, mechanical cutting and

loading, rock pressure and support, lining with beton blocks, and drainage of methane.

In coal preparation, research was mainly on cyclones with dense media cleaning.

Detailed research into the characteristics of Belgian coals, gas chromatography, composition of low temperature tars, and petrology of coals —these were the activities in the by-product studies.

Carbonization in a fluidized bed and low-temperature carbonization of coal briquettes were the activities in utilization work.

European Research Associates — Brussels. Research is essentially concerned with investigations related to the physical and chemical structure of bituminous coals using two methods. These involve techniques for the examination of whole coal or purified petrographic components using X-ray analysis, infrared, and ultraviolet spectroscopy, functional analysis of chemically reactive groups, statistical structural analysis, measurement of electrical conductivity and electron spin resonance. Results obtained in this way yield partial information on atomic arrangement in the molecular structure of coal and set empirical limits for the structure of coal taken as a whole. Methods have also been developed for the fractionation of the coal substance according to molecular weight and chemical type. They include solvent extraction at moderate temperatures, fractionation according to acid-base character, adsorption and gase-phase chromatography, as well as assorted chemical and physical methods.

Work has been mainly concentrated on a vitrinite of 99 percent purity obtained from a U. S. anthraxylon by flotation and centrifugation and its extraction products using the methods listed above.

The Netherlands

Central Laboratory (chemical research) of Staatsmijnen — Limburg, Geleen. Fundamental work is being continued on the chemical structure and properties of coal. In studies of the kinetics of coal carbonization, it was found that coals containing about 92 percent carbon give the greatest total amount of hydrogen, while the most methane is found in coals of 89 percent carbon. The maximum of the other hydrocarbons is found in coals of about 86 percent carbon.

In studies of the behavior of individual macerals and blends in the Audibert-Arnu Dilatometer, a definite correlation between the percentage dilatation and inert content was found. It is reported that the dilatation of any type of coal or mixture can be calculated from petrographic analysis of the individual coals.

Centraal Proefstation (mining research)—Hoensbroek, Treebeek. The Dutch State Mines has developed a heavy medium cyclone washing system which has been found practical in Europe in washing fine coal. Fines can be cleaned at any specific gravity from 1.30 on up and, at the same time, an extremely sharp separation can be made at any gravity required. Many washing plants are in operation using this system.

Spain

Instituto Nacional Del Carbon—Oviedo. Work has continued in the construction of additional research facilities for coal and coke research. Systematic studies have continued on coal preparation, classification and identification of reserves, revision of analytical standards and petrography.

A major research effort is directed to obtaining the maximum use of Spanish coals for the manufacture of blast furnace coke. Important work has been done on producing coke from very high volatile non-coking bituminous Spanish coals. The influence of coal size consist and oven width on coke quality has been investigated.

South Africa

Fuel Research Institute of South Africa—Pretoria, South Africa. The main subjects of research are chemical and physical survey of coal resources, coal preparation (mainly beneficiation by washing) and carbonization, with emphasis on the production of metallurgical coke.

Survey activities embrace studies of coal samples procured during prospecting and include petrographic studies, analysis of minor mineral constituents of coal ash, and new analytical techniques as well as determinations of the grindability characteristics.

The Institute has an elaborate pilot plant to conduct studies in washing characteristics of coals.

Tests used in assessing the value of coals for carbonization include the Gray-King assay, B. S. swelling in-

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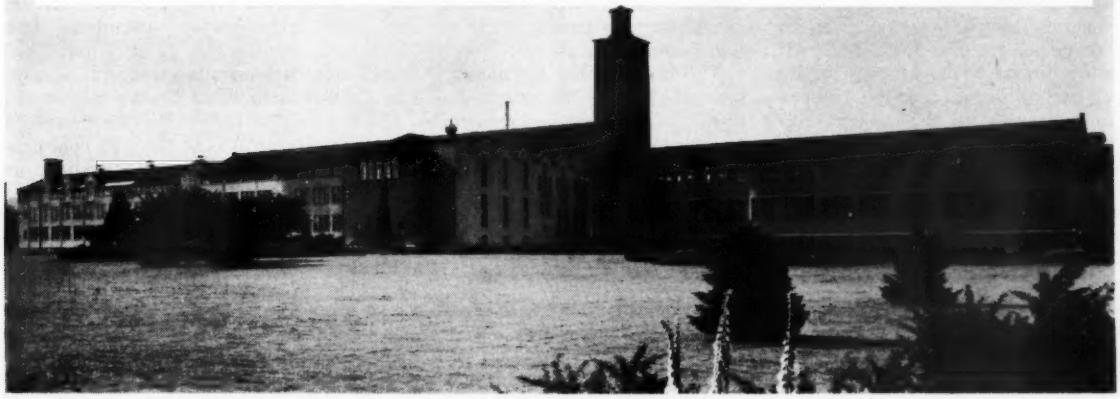
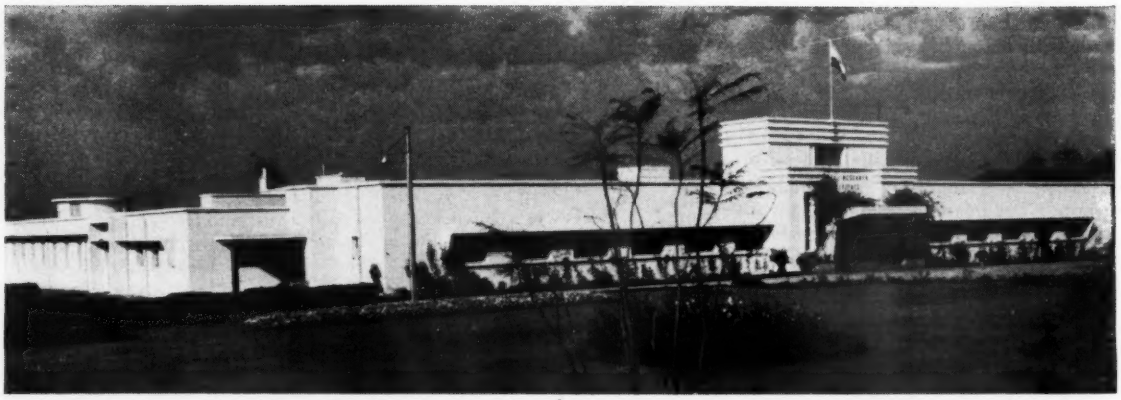




Work of India's Central Fuel Research Institute was devoted mostly to coal surveys, and preparation, utilization and carbonization studies

dex, Roga index, Gieseler plastometer, Hoffman and Audibert-Arnu dilatometers, vacuum distillation, and petrographic tests. Investigations of the effects of adding coal tar to weakly coking coal, of controlled crushing of coals, and microscopic studies of coke have been made.

Two gas-heated experimental ovens are currently being installed to supplement an electrically heated (Illinois Geological Survey type) test oven.

India

Central Fuel Research Institute—Dhanbad District, Bihar. Main effort of the Institute continued to be geared to the Five Year Plans and was devoted mostly to coal surveys, preparation, utilization and carbonization studies.

The extensive coal survey work included sampling; physical, chemical and petrographic analysis in a number of fields and seams; and the evaluation of the coals for specific use.

Preparation work involved various washability and beneficiation studies and included the investigation of frothing agents.

On the fundamental side of carbonization, studies were made on the thickness of the plastic layer, weathering of coals, kinetics of the coal carbonization reaction, laboratory assessment of the coking properties of coals and aromaticity and plastic properties of coal.

Work was continued on the recovery of pyridine bases from coal tar, recovery of gamma-picoline, manufacture of anthraquinone by the catalytic oxidation of anthracene, solvent extraction of phenols from coal tar, and conversion of higher tar acids to lower tar acids.

Studies in the gasification of coal dust have continued and the main components of the Koppers-Totzek dust gasifier have been installed.

Fluidized carbonization in a continuous carbonizer was also studied.

Work on binderless briquetting of coal and lignite showed that oxidized coals, like lignites, also exhibit maximum strength at an optimum moisture of about eight percent.

Fundamental and other studies on coal included: tests to determine the state of nitrogen in fertilizers made from coal, a new method for the estimation of aliphatic hydrogen in coal, mechanism of the Fischer-Tropsch reaction, distribution of sulfur in abnormal coals, sulfonation of coal, and studies of the active hydrogen in coal by deuterium exchange.

Japan

Coal Research Institute — Tokyo, Japan. Activities of the Institute include: fundamental studies of coal (analysis and calorimetry, petrography, specific properties), coal mining including hydraulic transport, coal preparation (crushing, screening, and ultrasonic wave and pneumatic coal cleaning), and coal utilization (carbonization, gasification, recovery of rare elements from coal, briquetting, treatment of tar and underground gasification).

The Institute has developed a new method of ultrasonic treatment of raw coal slurries for the separation of fine clean coal from raw slurry. The process is claimed to be simple and to have low power requirements. The application of ultrasonics is being studied for the acceleration of sink velocity of fine refuse.

Complete gasification of fine nonbituminous coal for the production of fuel gas and industrial gas is being studied by two processes. In one process an inversed cyclone type gasifier has been developed. The feed coal, oxygen and steam are injected tangentially into the gasifier, and the gasification is performed mainly on the gasifier wall covered with the slag film. The product gas and slag leave the gasifier through a center hole at the furnace bottom.

Australia

Coal Research Section, Commonwealth Scientific and Industrial Research Organization — Chatswood, N.S.W. Coal is Australia's principal source of energy, a base for its continuing industrial growth, and a potential source of new products and industries. It is widely varying in character, from good coking coal to brown coal.

The task of discovering new coal reserves and exploring their extent is the responsibility of the geological survey branches of the several state governments, while the Coal Research Section of the C.S.I.R.O. is responsible for fundamental and applied research directed toward the more efficient utilization of Australian coal. This also includes a detailed physical, chemical and petrographic survey of the coal reserves as they occur underground.

Principal areas of research interest are carbonization, chemicals from coal, combustion, gasification.

In carbonization research, a major effort of the Coal Research Section is devoted to improving the quality of metallurgical coke through coal preparation, grinding and blending, use of char as a blending agent, and pilot oven test work. Other work includes the possible applications of low temperature, fluidized-bed carbonization, the evaluation of the carbonizing properties of Australian coals on pilot scale, a study of the chemistry of coke formation by use of model compounds, and the effect of ex-

tended storage of coal on coke and gas-making properties.

In connection with the utilization of coal as a raw material for the manufacture of chemicals, research into its chemical nature continues. This includes degradation studies and functional group analysis. Studies of the infrared spectra of brown coal and lignin show an apparent simple chemical relation between the structure of the two materials. To evaluate further the possibilities of production of chemicals from coal, the Section is continuing its investigation into the properties, composition and structure of light oils, tars and pitches produced by carbonization of Australian coals. These studies are co-ordinated with parallel studies of the structure of coal itself. Investigation also continues into the constitution and formation of pitch.

In the area of combustion and gasification, investigations included a study of the aerodynamic factors in coke beds, the physical structure of cokes and chars, the changes in structure during carbonization, and the relation of pore structure to behavior during gasification.

The work of the Coal Research Section is continuing to expand and additional long-range researches on complete gasification and coal hydrogenation may be expected.

West Germany

The Steinkohlenbergbauverein — Essen. The industrial association of the coal mining interests, supports and fosters a broad research and development program extending over all phases from mining to conversion and utilization. General direction and coordination of the program is carried on through technical committees covering the various areas of interest, on which there is representation from both industry and the scientific staff.

With the opening of its new research center in 1958 at Essen-Kray, the Steinkohlenbergbauverein brought together in one place the research establishments and laboratories that had previously been scattered over the Ruhr region. Within the new research center are grouped:

a) Main Station for Mine Rescue Practice. This group continued its work in such areas as self-rescue, fire-protection, heat prostration, etc.

b) Main Station for Combating Dust and Silicosis. The activities of this group included investigation of the properties of dust by animal experiments, petrographic, physical and chemical means, of sedimentation and flocculation, and the effectiveness of various means and techniques of dust retention.

c) Research Station for Mine Ventilation. Both laboratory and field work are carried on to improve methods of measurement and control of mine atmosphere.

All other research establishments and activities were combined in two units:

d) Bergbau - Forschung GmbH (Mining Research Ltd.)

e) Bergwerksverband GmbH (Mining Association Ltd.)

The research and development work of the latter two, coordinated at the management level, falls principally to three large divisions at the research center: the Chemistry Division; the Physics, Petrography and Mineralogy Division; and the Coal and Coke Division.

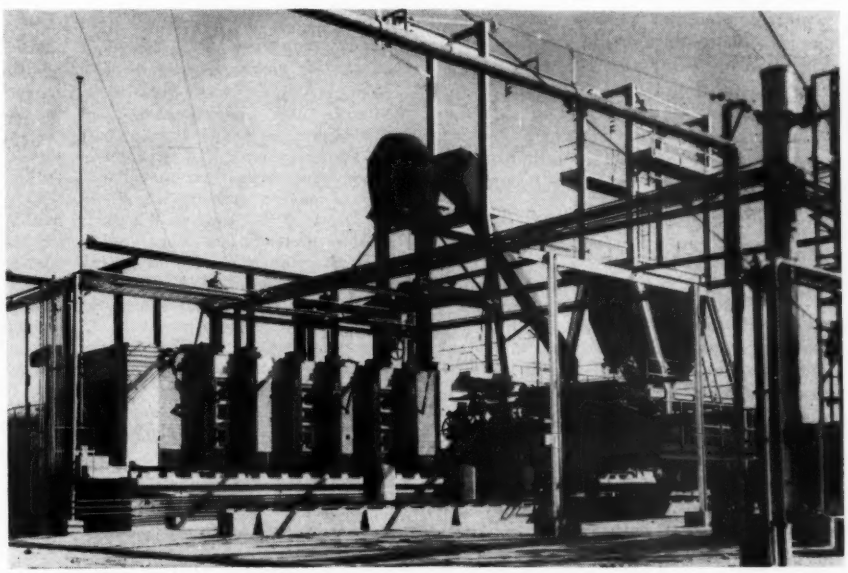
Chemistry Division. Work is progressing on effective, economic methods of converting toluol to terephthalic acid, the development of a number of ammonium thiocyanate based products, more effective removal of SO_2 from stack gas, the desalting of mine water, and the indirect air oxidation of benzol to phenol.

Attention was given to the production of new products via pressure oxidation of coal with nitric acid. Other work was concerned with the utility of special cokes made from oxidized pitch, the evaluation of graphitized carbons made from coal extracts, and the development of plastics from xylol-based pyromellitic acid and its by-products.

Division of Physics, Petrography and Mineralogy. Attention was given to the measurement and characterization of the strength of coke and briquettes, to pore structure and the size and structure of the internal surface of coal and coke.

A study of low temperature oxidation responsible for self-ignition of coal revealed that ammonia was an effective inhibitor. This has found practical application.

In a continuing cooperative program, investigations included the settling process of dust of different composition and electric charge, application of optical sedimentation meas-



Central Fuel Research Institute (India) used six-ton capacity pilot coke ovens for studying problems in the production of metallurgical coke. The plant has arrangements for blending, stamp charging, and top charging and includes ovens of different widths

urements to mine dusts, and the effect of electrical charge of coal dust on the formation of boiler tube deposits.

Several of numerous application possibilities of radioactive isotopes for the control of production and preparation procedures were investigated.

Coking coals were investigated according to macerals, bands and coal types with the emphasis on maceral analysis to characterize potential coking behavior. The work included the effect of variation of petrographic composition on the variation of coke quality, especially on strength and reactivity.

In cooperation with the mechanical coal preparation section, various wetting agents were investigated with regard to their hydrophylic or hydrophobic influence on the coal surface, as a basis for the development of a dewatering process.

A study is under way to clarify the effects of the physical, chemical, and aerodynamic factors involved in the fouling of heating surfaces.

X-ray measurements and electron microscopy were used to study the fine differences in crystal structure of graphite.

Division of Coal and Coke. The influence of both the heating velocity in the plastic zone and the final coke temperature on the mechanical properities of coke was investigated.

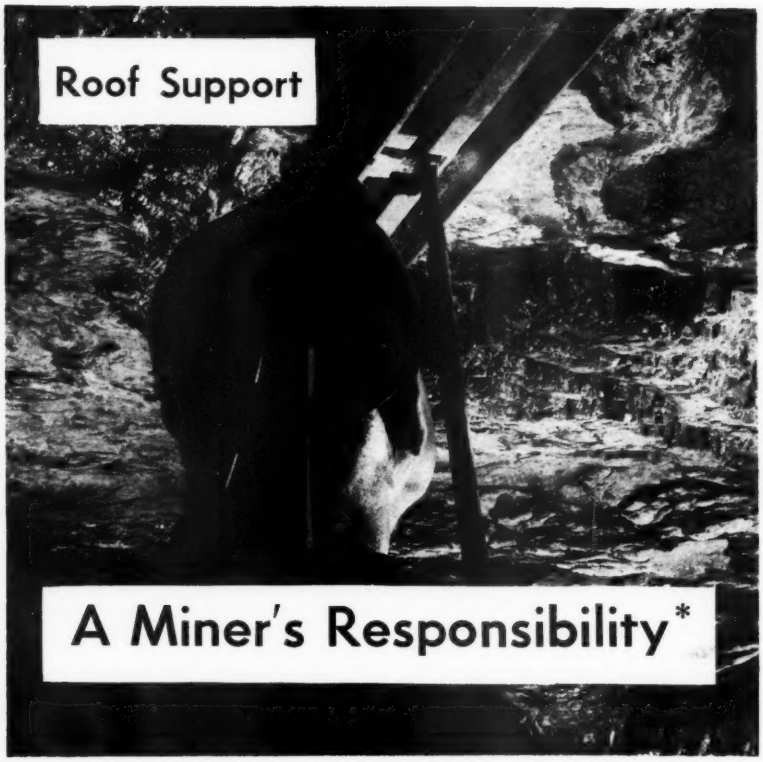
With the start-up of the new experimental coke plant, it was planned to study the influence of coking temperature, water content of coking coal, and varying bulk density on heat consumption, throughout capacity and yield of large-size coke.

Several artificial carbon product materials were developed.

A series of Convertol experiments connected with fine-coal preparation and dewatering were carried out. Additions of 0.2–0.5 per cent of paraffinic oil to the coal yielded major benefits in large scale flotation and slime dewatering tests.

Work in the area of briquetting included that on various types of coal tar pitch, the use of surface active agents to improve the wetting behavior of the binder, and the development of smokeless or relatively smokeless briquettes. Experiments were also in progress on the production of formed coke and its application in shaft furnaces.

With regard to activated carbon, studies were carried out on the influence of starting material and activation conditions on the properties of the end product.



A Miner's Responsibility*

Mining is a dangerous and complex undertaking. Many men are killed and injured annually in mines from falls of roof. That is why another "National Campaign To Prevent Injuries from Roof Falls" has been started. Its goal, to reduce such injuries by 50 percent over the next year, can be attained by concentrating on roof support methods, and on sound and practical rules and regulations. The objective of the campaign cannot be achieved by "going through motions" or by giving "lip service." Sincerity and effective action on the part of mine officials and men are prime requirements.

While the mine operator bears the greatest responsibility and expense for the prevention of roof fall accidents, there are many things that the miner can do to protect himself. His is a serious responsibility. He should avoid, for instance, defending a fellow workman for a violation of the necessary rules of the roof support program. A single violation may cause injury or death!

Some other things a miner must do to prevent accidents are:

1. Be sure not to proceed or work inby the last permanent support, unless authorized to make the roof safe. Use temporary support.
2. Properly examine and evaluate roof conditions. "Drummy" or loose top that can't be properly supported should be taken down.
3. Follow the *standard* roof support plan. If an abnormal condition is encountered, use additional support.
4. Check especially for irregularities in the roof, such as rolls, slips, or mud seams.
5. Watch for dangerous roof conditions and, when found, ask mine officials to remedy them.

Mining laws and company rules prohibit a miner from working under unsupported roof. However, experience has shown that these regulations are too frequently violated. Compliance with the roof support program should be obtained through training, supervision, enforcement, and discipline. The use of diagrams and blueprints showing proper methods of roof support are necessary to instruct a miner in what is expected of him.

Remember to put in constant reminders as the work goes along. Tell your men to always be alert to the hazard of roof falls and not to jeopardize their lives or the lives of their buddies. Remind them to always follow the timbering plan; there is no substitute for safe timbering practices. Remember the three "T's" for safety:

1. **Test**
2. **Takedown**
3. **Timber**

** Prepared by the Advisory Committee 1960 National Campaign to Prevent Injuries from Roof Falls in Coal Mines.*

Can Peaceful Nuclear Explosions Be Conducted Safely?

By CHARLES E. VIOLET
Test Division Leader
University of California
Lawrence Radiation Laboratory

At inception of the Plowshare Program, it was recognized that study and resolution of safety problems must proceed as an integral part of this program

FOR the past two years the U. S. Atomic Energy Commission has sponsored a program to explore peaceful uses of nuclear explosives. The over-all responsibility for this program, which is called Plowshare, resides with the AEC. The technical portion of the Plowshare Program is the responsibility of the Lawrence Radiation Laboratory which is operated under a contract between the Atomic Energy Commission and the University of California.

At the inception of the Plowshare Program it was recognized that a number of safety problems would arise in connection with these uses. It was also recognized that the study and resolution of these problems must proceed as an integral part of the program.

The purpose of this article is to consider the important safety problems associated with peaceful applications of nuclear explosives, as well as to delineate problems which appear to be well understood from those which require further study and experimentation.

Peaceful Uses and Hazards

The energy released from a nuclear explosion appears in three forms—mechanical, thermal and radiation. The various industrial and scientific uses of nuclear explosives which have been considered make use of one or more of these energy forms.[1,2] With this as a basis of classification, several proposed uses are summarized in table I.

Table I. Industrial and scientific uses of nuclear explosions

Heat	Mechanics	Radiation (Neutrons, Light)
Power generation	Excavation of harbors and canals	Isotope production
Salt-water distillation	Improvement of underground water supplies	Neutron physics
Petroleum Tar sand Secondary recovery	Mining Removal of overburden Block caving Preparation for in situ leaching Petroleum Oil shale Secondary recovery Seismological research	

The hazardous aspects of nuclear explosions can also be categorized on the same basis. Thus mechanical energy is associated with ground shock and air blast, thermal energy with incendiary effects, and radiation with radiological hazard.

The peaceful applications which have been considered involve, with the exception of outer-space experiments, partially or completely contained explosions. This is due in part to the marked reduction (by a factor of 100 or more) in the air blast, thermal and radiological hazards made possible by releasing nuclear energy underground. The use of clean nuclear explosives in which 95 percent or more of the energy released comes from fusion rather than fission also would be a major factor in minimizing the radiological hazard. The seismic signal is one effect that increases for buried detonations. However, this increase is only a factor of three for contained detonations compared to surface detonations.

The decrease of both airborn activity and airblast with depth is compared in figure 1 with the variation of excavation volume.

The radiological data of figure 1 is based on nine underground nuclear detonations.[3] Whereas blast data is based on chemical explosive experiments.[4] Nuclear blast data is expected to be very similar. The excavation data is based on both nuclear and chemical explosive experiments.[5]

The data in figure 1 is obtained from explosions of various yields. This information has been normalized to a one-kiloton yield by plotting the data in terms of scaled depth, which is the actual depth divided by the cube root of the energy release in kilotons. The curves of figure 1 are, therefore, an approximate representation of the expected effects from a one-kiloton nuclear explosion. With respect to excavation applications it is notable that the scaled depth for maximum excavation occurs where the airborne activity and the air blast are reduced by at least a factor of 100 compared to a surface burst.

Phenomenology

Underground nuclear explosions are fairly well understood from both experimental[3] and theoretical viewpoints.[6] Since an understanding of phenomenology is necessary to a safety evaluation, a brief review is presented here.

In a nuclear detonation there is an immense amount of energy released

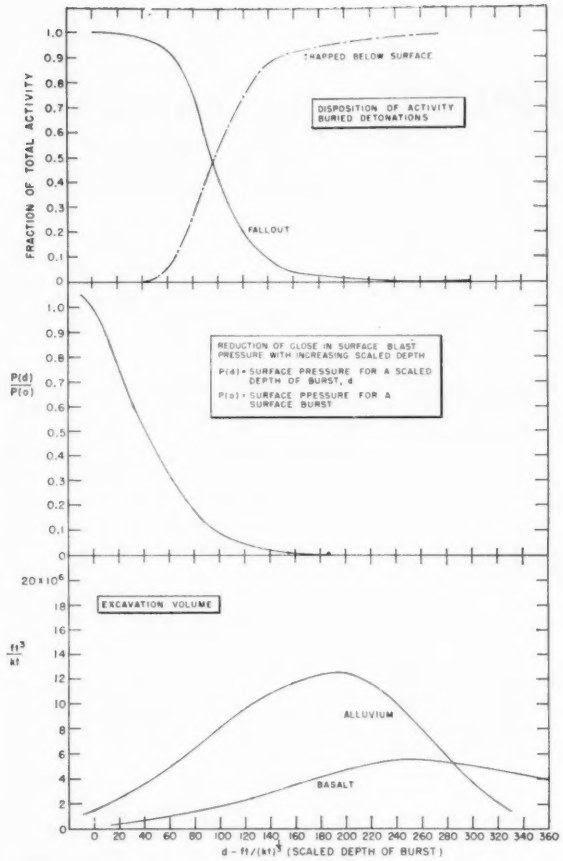


Fig. 1. Approximate representations of the expected effects from a one-kiloton nuclear explosion

almost instantaneously in a very small volume. Under these conditions, the energy released will be imparted to the environment by means of a shock wave. The initial temperature and pressure across the shock front are of the order of millions of degrees and millions of atmospheres, respectively. The shock wave is thus strong enough to initially vaporize the rock. As the shock wave moves outward and becomes weaker the rock will then be successively melted, crushed and fractured. Behind the shock wave material moves outward and a cavity is formed. For a yield of one kiloton, the radius of this cavity is about 50 ft. The amount of melted rock lining the cavity is about 500 tons per kiloton. The gas filled cavity stands briefly and then collapses. A broken zone is then formed above the cavity as successive collapses progress upward until this volume is filled with broken material or the surface is encountered. In the latter case, venting of the cavity gases to the atmosphere takes place. The shock wave crushes the rock out to a distance of about 100 ft for a one-kiloton explosion and beyond about 300 ft the rock behaves elastically. These dimensions also scale as the cube root of the yield. The fraction of the total yield that escapes as an elastic wave (seismic signal) is about five percent.

With this as background we shall consider in more detail three hazards, namely, radiological, ground shock and air blast. These are the only safety problems of any pertinence to the applications of table I. The depths of burial are such that thermal effects do not present a hazard for these cases.

Radiological Hazard

First consider the disposition of radioactivity in contained nuclear explosions. If the explosion is in rock with an appreciable silica composition, such as the tuffaceous environment of the Nevada explosions, the molten rock lining the cavity is a relatively insoluble glassy matrix in which the major fraction of fission products is incorporated.

Those radioactive fission products which are still in a gaseous state when the cavity collapses are not incorporated but escape from the cavity into the surrounding broken material. Consider, for example, the production of Sr^{90} in the fission process. Most of the material that finally exists as Sr^{90} is produced in the fission process as an isotope of the inert gas krypton, namel Kr^{90}. Kr^{90}, which has a half-life of 33 sec, decays into Rb^{90}, which decays with a half-life of 2.7 min into Sr^{90}. Thus if the cavity collapses and vents at a time comparable to the half-life of the Kr^{90}, a major fraction of the final Sr^{90} will escape from being trapped in the molten material. Thus appreciable amounts of Sr^{90} and other nuclides with rare gas precursors or nuclides of volatile elements could be deposited on the surface of broken material at appreciable distances from the highly radioactive molten shell.

Using the same reasoning for partially contained explosions, the fraction of radioactive debris which vents to the atmosphere should be rich in the rare gas and volatile fission products. Sr^{90} and Cs^{137} should appear enriched relative to the expected distribution of fission products to an extent determined by the time of venting. For example, samples of the vented debris from Blanca[3] (a 19-kiloton explosion at a scaled depth of 300 ft, which vented 0.3 to 0.5 percent of the total fission activity at 15 sec after zero time) were enriched about fivefold in Sr^{90}. Thus about two percent of the total Sr^{90} formed in the explosion was actually released to the atmosphere. However, atoms of Rb^{90} and Sr^{90} deposit rapidly upon the surface of the particulate matter which is blown out of the crater with the vented gas, and are therefore promptly scavenged from the atmosphere as the particulate matter falls out.

From this discussion it follows that the formation of an insoluble glassy material during the explosion does not guarantee the trapping of all undesirable radioactivities. Moreover, enriched quantities of Sr^{90} and Cs^{137} would be expected to appear in the broken rock outside of the fused shell and, for partially contained explosions, on the ground surface.

Local and World-Wide Fallout

In the case of excavating explosions the character of the fallout is markedly changed from that of nuclear explosions in the atmosphere. In the latter case it is convenient to divide the fallout into two classes, local and world-wide. Local fallout is associated with that fraction of the total activity which remains in the troposphere. For typical meteorological conditions this fallout occurs over a period of about ten hr and over an eliptically-

shaped area with a major dimension of 150 to 250 miles. The fraction of the total activity that enters the stratosphere falls very slowly and produces a more-or-less uniform distribution of fission products on the earth's surface.

For excavation explosions where the scaled depth is approximately 200 ft per kiloton$^{1/3}$, the cloud height would be much lower than for surface or air bursts. Thus it is not expected that any radioactive debris would enter the stratosphere and contribute to the world-wide fallout. Also, present data indicate that the scavenging effect of the particulate matter blown out of the crater removes 90 to 99 percent of the vented activity, including Sr^{90} and Cs^{137}, from the atmosphere. The presence of this air-borne material also reduces the fallout time and distance by a factor of about five. Thus essentially all of the activity including 90 to 99 percent of the Sr^{90} and Cs^{137} would fall out in a few hours within a distance of about 50 miles. These numbers are probably uncertain by a factor of two. Detailed study of these phenomena are planned in Plowshare cratering experiments.

The activity that is trapped underground is normally unavailable to plants and animals. If the activity is accessible to ground water it could conceivably become available to the biosphere. Therefore, it is important to consider what would happen if a nuclear explosion occurred in an aquifer.

Ground Water Contamination

The flow of activity in ground water has been extensively studied both in this country and elsewhere in connection with the disposal of radioactive waste products. The results of these studies[7] show that the flow of activity in ground water can be expressed by means of the following relation:

$$F_A = F_W \frac{1}{1 + K_D}$$

where K_D is the distribution coefficient for natural occurring minerals ranging from minimum of about 100 for Sr^{90} in limestone to 100,000 for Ce^{144}. Using a typical flow rate for ground water of three feet per day and assuming $K_D = 300$, the average flow of Sr^{90} in the medium would be one foot in 100 days. Thus in a time equal to the half-life of Sr^{90} (28 years) the Sr^{90} activity would have moved 100 ft. Thus, it is possible, by having knowledge of the hydrology of an area and by making laboratory measurements of the distribution coefficients for the minerals in contact with the ground water for the biologically undesirable nuclides, to predict the disposition of these radioactivities in the ground water. Prior to any specific experiment, these detailed studies would be conducted to assure that no ground-water contamination would occur. In general, because of the ion exchange characteristics of naturally occurring media, ground-water contamination does not appear to present any hazard.

Induced Radioactivity

So far we have been considering the radioactivities produced in nuclear explosions by nuclear fission. Radioactive products are also made by the neutrons released from nuclear explosions. These neutrons, produced in the fission process, are captured in nuclei of the materials surrounding the explosion. Neutron capture by nuclei produces radioactive isotopes of those nuclei. These are well known and extensively studied processes in nuclear physics. Radioactivities produced in this way are called induced activities as distinguished from fission-product activity. In underground explosions essentially all of the neutrons are captured in three ft of soil. The induced radioactivities are thus contained in the initially vaporized and melted zones as are the fission product activities. For typical soils, the magnitude of the induced activity is generally a few percent of the fission product activity. The contribution of the induced activities to the total can be readily calculated for any soil of known composition. Sr^{90} and Cs^{137} are not produced by neutron activation of soil materials. In any case neutron activation can be controlled if desired by surrounding the explosive with borated material which captures neutrons without producing radioactivity. The potential radiological hazard from neutron activation is negligible compared to that associated with fission product activity.

Ground-Motion Effects

Extensive measurements have been made of ground motion produced by contained and partially contained nuclear explosions at the Nevada Test Site. The phenomena are measured and described in terms of such quantities as earth acceleration, particle velocity displacement and strain. In addition to these measurements the effects of these underground nuclear explosions on nearby tunnels and surface structures have been studied and documented.

The seismic signal and the associated effects are conveniently discussed in terms of earth accelerations. The surface accelerations for underground explosions are related by the formula:

$$A = \frac{0.06\ W^{2/3}}{R^2}$$

where A = peak accelerations in g's,
W = energy release in kilotons,
R = range in miles.

This formula predicts within a factor of two or three the peak accelerations from both chemical explosives and nuclear explosives over a range of a few thousand feet to a few thousand miles. Earth accelerations have been correlated with earthquake intensity which is based on the effects of earthquakes on people and structures. With this information the effects of a given explosion can be predicted. For example, the expected surface ground motions from a ten-kiloton explosion in terms of acceleration and earthquake intensity are given in table II.

The effects on underground structures such as mines are less than those on the surface at the same distance. Measurements of this effect demonstrate that the reduction of earth accelerations and displacements underground is generally a factor of two.

This discussion and the data of table II apply to the accelerations that are in the potentially damaging frequency range of one to ten cycles which are close to the natural frequency of most structures. Ground motion outside of this frequency range does not cause any significant damage.

Table II. Surface motion from a buried ten-kiloton explosion

Range (miles)	Peak Accelerations (g's)	Earthquake Intensity (Modified Mercalli Scale)	Effects
1	0.34	8	Damage slight in specially designed structures; considerable in ordinary substantial buildings
5	0.014	4	Rattle windows and disturb movable objects. Felt indoors by many, outdoors by few
10	0.003	3	Noticeably felt indoors. Vibration like passing of truck
15	0.0015	1–3	Felt by sensitive people
25	0.00054	—	Not felt

Air-Shock Effects

A large explosion in the atmosphere generates a shock wave with high peak pressures close in which decays to a simple sound wave at large distances. At large distances where the sound wave is normally weak, meteorological conditions may be such as to cause it to be redirected toward the earth's surface. In addition the sound wave may be reinforced on its downward path by refraction from various layers in the earth's atmosphere. These effects either separately, or in combination, may turn an otherwise innocuous sound wave into a hazard. The effects are conditioned by the temperature and wind distribution that exists in the atmosphere at the time of the explosion. There are three regions in the earth's atmosphere that give characteristic refracted signals; the troposphere, the ozonosphere and the ionosphere. Only in the troposphere are adequate meteorological data available. The portion of the blast wave that is refracted or directed by the troposphere generally arrives at the earth's surface at distances of about 100 miles. Predictions of troposphere signals based on meteorologic observations alone are generally accurate to within a factor of two. Recording of chemical explosive detonations with microbarograph stations can be correlated with theoretical calculations to aid in arriving at better predictions. While adequate meteorological information on the ozonosphere and ionosphere winds are not available, these winds are at least fairly constant in time. Therefore blast predictions for these layers are obtained directly from microbarograph recordings of chemical-explosive detonations. This procedure generally gives predictions which are accurate to within 20 to 30 percent.

Evaluation of Safety

When one considers the possibility of nuclear explosives for peaceful purposes two questions immediately come to mind: 1) Can the energy released do useful work? and 2) Can the hazards be controlled?

These questions are not unique to these applications. They are implicit in each discovery of a new energy source. The technology that always follows on the heels of such a discovery provides for the control of hazards as well as the efficient use of that energy. The task of the Plowshare Program is to develop the technology of nuclear explosions for peaceful uses. This includes the resolution of the problem of how the hazards can be reduced to an acceptable minimum.

Based on our present state of knowledge of underground nuclear explosions, which is summarized herein, it is possible to make the following judgments:

Air Blast. This hazard occurs only for partially contained explosions (excavation application). If the excavation site is sufficiently remote from centers of population no damage should occur from this effect. Present information indicates that with proper accounting for meteorological conditions, major construction projects such as harbors or canals which may involve buried charges of several megatons yields, can be undertaken up to 50 miles of population centers. This distance is uncertain by perhaps a factor of two and needs to be refined by further nuclear experiments.

Ground Motion. This effect is fairly well understood at present. All underground nuclear detonations so far have occurred in only two media—tuff and alluvial fill. Future nuclear experiments should be used to establish seismic effects associated with other media, although this is probably not a significant effect. Again, this hazard can be controlled by choice of site sufficiently remote from population. For major construction a distance of 30 miles is probably adequate.

Radiation. This hazard will be discussed in terms of three safety problems: 1) Activity on the earth's surface; 2) activity underground; and 3) disposition of biologically undesirable isotopes (notably Sr^{90}).

1) ***Activity on the Surface:*** This would be a problem only in excavation applications. For any given time after a major excavation job there would exist two zones: zone 1, where the activity produced by the explosion is greater than the natural background; and zone 2, where it is less. Clearly zone 2 does not present a radiation hazard whereas zone 1 does. Although the major dimension of zone 1 may extend 50 to 100 miles, using presently available explosives, its size decreases rapidly during the first few weeks and at a slower rate at later times. By appropriate surveillance of zone 1, access to it can be controlled. This would be done to meet previously specified radiation limitations. At the present time an adequate guide line has been provided by the International Commission on Radiological Protection. It recommends that the total permissible genetic dose prior to age 30, "****to the whole population from all sources additional to the natural background should not exceed five roentgens plus the lowest practical contribution from medical exposure."

2) ***Activity Underground:*** From the considerations as previously discussed under phenomenology, it appears that with proper care and planning, the ground-water contamination problem does not appear to place any serious limitation on peaceful uses of nuclear explosives.

3) ***Biologically Undesirable Isotopes*** (Sr^{90}): Since Sr^{90} is probably the most serious biological hazard of all fission products we will limit our discussion to this isotope. Earlier discussion shows that the possibility of Sr^{90} contamination of ground water is a hazard which can be controlled.

However, in cases of nuclear excavations the explosions are partially contained and a fraction of the Sr^{90} produced is vented to the atmosphere. The question then becomes—what significance does this have in terms of radiological hazard?

Prompt Fallout of Sr^{90}

A model for a typical excavation explosion is the Neptune event.[3] This explosion took place at a scaled depth of 200 ft and deposited one to two percent of the fission product activity on the surface. Measurements on the vented debris showed that the Sr^{90} enrichment was about a factor of five. Thus the amount of Sr^{90} vented to the atmosphere was five to ten percent of that produced in the explosion. However, 90 to 99 percent of the vented Sr^{90} descends to earth with the prompt fallout. Thus for a major construction project, the fraction of Sr^{90} which could reach the stratosphere and become available to fallout over large areas of the earth's surface is negligible compared to the Sr^{90} already present on the earth's surface and in the atmosphere.

The Sr^{90} which descends in the prompt fallout remains in a well defined area with a maximum dimension of about 50 miles. This presents a hazard stemming from the Sr^{90} existing on plants that are eaten directly by man or animals in his food chain. Since nuclear excavations would proceed in relatively remote regions, at least until more experience

is accumulated, it is not likely that this Sr^{90} would become available to agricultural activities.

This entire question of possible interaction of fission products, especially Sr^{90}, with man's food chain would have to be examined in detail for any specific excavation project. Such questions are being examined by the AEC's Division of Biology and Medicine in connection with Project Chariot (excavation with nuclear explosives of a harbor at Cape Thompson, Alaska). These studies indicate that with proper choice of excavation sites and surveillance of the critical areas, the Sr^{90} problem can be controlled.

Plowshare To Provide Some Answers

Underground nuclear detonations which have been conducted as part of nuclear weapons tests have provided valuable information pertinent to the technical and safety aspects of Plowshare. This data is continuing to provide input to safety and technical evaluation and planning for specific Plowshare projects.

At present it appears that the airblast and ground-shock problems are well understood. More information is needed, however, on the behavior of distant air-pressure signals for partially contained nuclear explosions.

The radiological hazard is the most complex and apparently less subject to objective guide lines. Nuclear experimentation as set forth in various Plowshare project proposals is necessary to provide a more accurate measure of the ultimate disposition of fission products for contained or partially contained explosions.

On the basis of extensive evaluation of all information on underground nuclear explosions it appears that the answer to the title question can be readily given. Continued study and experimentation will undoubtedly confirm that the answer is indeed, yes.

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1. G. W. Johnson, H. Brown, *Scientific American*, December 1958.
2. ———, UCRL-5675, 5676, 5677, 5678 and 5679, Plowshare Series, "Proceedings of the Second Plowshare Symposium," May 13-15, 1959, San Francisco, Calif.
3. G. W. Johnson, G. Higgins, and C. Violet, *Journal of Geophysical Research*, October 1959.
4. B. F. Murphy, E. S. Ames, Private Communication, Sandia Corp., February 1959.
5. A. J. Chabai, Sandia Corp., SC-4391(RR), December 1959.
6. J. Nuckol's, UCRL-5675, "Proceedings of the Second Plowshare Symposium," May 13-15, 1959, San Francisco, Calif.
7. G. Higgins, *Journal of Geophysical Research*, October 1959.

1960 AMC COAL CONVENTION

The National Program Committee, under the chairmanship of R. H. Hughes, President, Clinchfield Coal Co., has come up with a rich "bill of fare" for the 1960 Coal Convention of the American Mining Congress, the industry's outstanding meeting of the year.

Of particular interest will be the opening session at which leading members of Congress and Government officials will consider various matters affecting a National Fuels Policy. At other sessions recognized authorities will spell out technical advances in mining methods and machinery, coal preparation, and safety. Important management problems will also be discussed.

An all-day Tax Forum on Wednesday will be of special interest to accountants and others handling tax matters, and a panel discussion Wednesday afternoon on stream pollution problems will draw the attention of those working with various agencies on "clear streams" legislation.

Others highlights of the week include two feature luncheons, two gala evening events, and a program of daytime entertainment for the ladies. Thursday, May 12, will be given over to trips of special interest to coal mining men.

All in all, the 1960 AMC Coal Convention promises mining men a fine opportunity to "catch up" on the progress and future development of the Nation's vital coal mining industry.

The following Advance Program, with a description of each paper, will enable each of those attending to best plan his time for a profitable week.

TIME: May 9-11

PLACE: Pittsburgh— The Coal Capital of the World

IMPORTANCE: A Must

Advance Program

MONDAY—MAY 9

9:45 A.M.—NATIONAL FUELS POLICY

Opening of Convention

RAYMOND E. SALVATI, *President, Island Creek Coal Co.; President, American Mining Congress*

Presiding—

GEORGE H. LOVE, *Chairman of the Board, Consolidation Coal Co.*

Congressional activity and the work of various Government agencies bear directly on coal's future. The following panel participants will discuss matters bearing on National Fuels Policy.

HON. ELMER F. BENNETT, *Under Secretary of the Interior*

HON. WAYNE N. ASPINALL, *U. S. Representative from Colorado; Chairman, House Committee on Interior and Insular Affairs*

HON. FRANK E. MOSS, *U. S. Senator from Utah*

HON. JOHN P. SAYLOR, *U. S. Representative from Pennsylvania*

DR. FRANK K. PITTMAN, *Director, Division of Reactor Development, Atomic Energy Commission*

R. A. KAMPMEIER, *Assistant Manager of Power, Tennessee Valley Authority*

Discussion:

12:00 Noon—WELCOMING LUNCHEON

Presiding—RAYMOND E. SALVATI, *President, American Mining Congress*

Welcome to Pittsburgh

HON. JOSEPH BARR, *Mayor of Pittsburgh*

Responses:

JESSE F. CORE, *Vice President—Operations—Coal, U. S. Steel Corp.; Chairman, Coal Division, American Mining Congress*

ROBERT H. HUGHES, *President, Clinchfield Coal Co; Chairman Program Committee, 1960 Coal Convention*

ALBERT E. SEEP, *President, Mine & Smelter Supply Co.; Chairman, Manufacturers Division, American Mining Congress*

Address:

HON. FRED A. SEATON, *Secretary of the Interior*

George C. Breidenbach
Vice President
T. J. Gundlach Machine Co.

Cletus A. Broecker
Vice President
Ayrshire Collieries Corp.

J. Allan Brookes
Manager
Mather Collieries, Pickands Mather & Co.

MEMBERS OF PROGRAM COMMITTEE— 1960 COAL CONVENTION

R. H. Hughes
(Chairman), President
Clinchfield Coal Co.

Stephen Canonico
Vice President
Compass Operations, Clinchfield Coal Co.

Edward J. Carroll
Sales Manager
Mining Tool Div., Kennametal, Inc..

L. H. Chalfant
Manager
Bethlehem Mines Corp.

George J. Clark
President
Reading Anthracite Co.

Charles W. Connor, Jr.
General Superintendent
Gary District-Coal Div., U. S. Steel Corp.

Jesse F. Core
Vice President
Coal Div., U. S. Steel Corp.

R. J. Craig
General Manager
Rochester & Pittsburgh Coal Co.

Jefferson J. Davis
Vice President
Electric Steel Foundry Co.

Monday, May 9 (cont.)

2:15 P.M.—STRIP MINING

CHAIRMAN—S. F. SHERWOOD, *President, Stonefort Coal Mining Co., Inc., Indianapolis, Ind.*

VICE CHAIRMAN—J. J. HUEY, *Director of Engineering, United Electric Coal Companies, Chicago, Ill.*

Recent Developments in Blasting Overburden

(a) **With Ammonium Nitrate**

The importance of particle size, loading density, admixed oxidizing agents, particle density, confinement, etc. in the effective use of ammonium nitrate as a blasting agent has been evaluated by laboratory and field research. As a direct result a number of new inexpensive blasting agents have been devised and are finding wide application.

DR. GEORGE B. CLARK, *Chairman, Department of Mining Engineering, University of Missouri, School of Mines and Metallurgy, Rolla, Mo.*

(b) **Moving Overburden with Explosives**

Is it cheaper to move overburden with explosives than with mechanical equipment? One coal company believes so and will present facts and figures to prove the point.

AUGUST MANIFEST, *Mine Superintendent, Marco Coal Co., Apollo, Pa.*

A New Approach to Drilling Overburden

Hanna Coal Company is conducting experiments to see if more efficient overburden blasting can be achieved by drilling blast holes parallel to the face of the highwall instead of vertically.

Representative of Hanna Coal Co., Cadiz, Ohio

The Electric Wheel Drive

The electric wheel drive has excited great interest among open pit miners everywhere. A description of one such unit that is in operation at a large Montana copper mine will be followed by a discussion of potential use in the coal industry.

E. R. BORCHERDT, *Borcherdt & Smith, San Francisco, Calif.*

Discussion: WAYNE McGLADE, *Manager of Engineering and Research, LeTourneau-Westinghouse Co., Peoria, Ill.*

J. L. VINT, Jr., President, Unit Rig & Equipment Co., Tulsa, Okla.

2:15 P.M.—THIN SEAM MINING

CHAIRMAN—GEORGE E. EVANS, JR., *President, Evans Elkhorn Coal Co., Inc., Wayland, Ky.*

VICE CHAIRMAN—L. I. COTHERN, *Director of Engineering, Jewell Ridge Coal Corp., Tazewell, Va.*

Conventional Mining in Thin Seams

To stay in business mining thin coal, a commercial operator must make "efficiency" his unyielding creed. Here is how one company constantly upgrades its performance.

E. W. POTTER, *Vice President and General Manager, Royalty Smokeless Coal Co., Clifftop, W. Va.*

Continuous Mining in Thin Seams

The development of thin seam mining systems and equipment will be traced, with emphasis on the transition to continuous mining.

K. S. HOBBS, *Mine Superintendent, Eastern Gas & Fuel Associates, Helen, W. Va.*

Equipment Needs and Trends for Thin-Seam Mining

A summary of advances in the technology of mining thin seams, concluding with an outline of anticipated equipment needs.

NEIL ROBINSON, *Robinson & Robinson, Charleston, W. Va.*

Research in Hydraulic Coal Mining

Coal can be mined hydraulically. The paper will present the results of experiments being conducted by the U. S. Bureau of Mines, covering such aspects as nozzle size, water pressure and mining method.

JOSEPH J. WALLACE, *Supervising Mining Methods Research Engineer, U. S. Bureau of Mines, Pittsburgh, Pa.*

Charles B. Elledge
Manager of Equipment Industries Sales
General Electric Co.

P. P. Ferretti
President
Pocahontas Fuel Co.

R. W. Fox
Vice President
Production,
North American
Coal Corp.

7 P.M.—COAL MINERS PARTY

Dinner, dancing and a top-flight floor show

A. G. Gossard
Vice President and
General Manager
Snow Hill Coal Corp.

Cecil Guthrie
Vice President
Strip Operations,
Peabody Coal Co.

H. J. Hager
Vice President
Operations,
Alabama By-Products
Corp.

W. A. Haley
Mining Representive
Caterpillar Tractor Co.

J. L. Hamilton
Executive
Vice President
Island Creek Coal Co.

Henry Harnischfeger
President
Harnischfeger Corp.

H. John Harper
Vice President
Coal Operations,
Eastern Gas & Fuel
Associates

C. T. Hayden
Vice President
Sahara Coal Co.

Robert G. Heers
Manager of Mining &
Raw Materials
Kaiser Steel Corp.

G. R. Higinbotham
President
Mountaineer Coal Co.

James Hyslop
President
Hanna Coal Co.

David Ingle, Jr.
President
Ingle Coal Corp.

TUESDAY—MAY 10

9:30 A.M.—SAFETY

CHAIRMAN—WILLIAM E. HESS, ***Manager of Mines, Jones & Laughlin Steel Corp., California, Pa.***

VICE CHAIRMAN—D. C. RIDENOUR, ***General Superintendent, Olga Coal Co., Coalwood, W. Va.***

Progress in Roof Control—A Panel Discussion

Control of mine roof is a problem that will always face underground miners. However, there have been several recent developments which promise additional valuable tools in controlling mine roof—including roof cementation, sonar exploration and plain old ingenuity.

Roof Cementation

D. F. CRICKMER, ***Chief Engineer, Pocahontas Land Co., Bluefield, W. Va.***

Sonar Exploration of Roof Rocks

DR. CHARLES E. MONGAN, JR., ***Consulting Physicist, Cambridge, Mass. and*** **THOMAS C. MILLER,** ***Mining Health & Safety Engineer, U. S. Bureau of Mines, Pittsburgh, Pa.***

A Practical Look

A. V. GIBSON, ***Division Superintendent, New River & Pocahontas Consolidated Coal Co., Havaco, W. Va.***

Progress in Ventilating Continuous Mining Sections

The author will compare the use of line brattice and tubing in ventilating a continuous mining section. The report will include accurate volumetric methane content readings for each 10 ft advance, as well as a comparison of temperatures and entrained dust particles in the return air current.

C. H. PATTERSON, ***Safety Director, Rochester & Pittsburgh Coal Co., Indiana, Pa.***

Discussion: JOHN B. KEBBLISH, ***General Superintendent, Mountaineer Coal Co., Fairmont, W. Va.***

Fire Fighting Experience

In fighting a large mine fire in New Mexico, valuable experience was gained in the use of a foam plug to advance into and recover burned areas. Included will be a description of results obtained by passing fire gases through a carbon dioxide chamber and introducing the resultant mixture into the fire area.

W. K. DENNISON, JR., ***Mine Superintendent, Kaiser Steel Corp., Raton, N. M.***

C. O. Kane
Manager
Coal Mines,
Armco Steel Corp.

Ralph E. Kirk
Kirk & Cowin, Inc.

Ralph Kress
LeTourneau
Westinghouse Co.

9:30 A.M.—COAL PREPARATION

CHAIRMAN—R. M. VON STORCH, ***General Superintendent, Coal Mines & Quarries, Columbia-Geneva Steel Division, U. S. Steel Corp., Provo, Utah***

VICE CHAIRMAN—A. P. MASSMANN, ***Preparation Superintendent, Peabody Coal Co., St. Louis, Mo.***

Some Economic Aspects of Coal Preparation

A preparation program, to justify its cost, must permit increased realization, retention or expansion of markets, or decreased mining costs. All factors must be properly evaluated to insure maximum economic benefit to the producer.

F. R. ZACHAR, ***Consulting Engineer, Morgantown, W. Va.***

Progress in Preparation Plant Automation

A large coal producer has increased preparation plant efficiency by automatic measurement of dense medium gravity, automatic sampling, and automatic control of railroad cars under the loading point.

R. E. JOSLIN, ***Manager Preparation, Clinchfield Coal Co., Dante, Va.***

Preparation Plant Maintenance

A case history of how maintenance of a 240-tph fine coal plant was reduced by redesigning the flow sheet to eliminate four drag tanks, a distributing conveyor, four cyclones and two large pumps.

DAVID G. WERNER, ***Maintenance Engineer, Pittsburgh Coal Co., Library, Pa.***

What's New in Anthracite Preparation?

The latest innovation to reduce production costs is the recent introduction of an automatic density control robot for dense medium coal preparation systems.

J. E. IPPOLITI, ***Chief Engineer, Wilmot Engineering Co., White Haven, Pa.***

Tuesday, May 10 (Cont.)

12:00 P.M.—LUNCHEON

PRESIDING—ALBERT E. SEEP, ***Chairman, Manufacturers Division, American Mining Congress***
Address—*"Behind the Scenes in Washington"*
RICHARD HARKNESS, ***NBC News Commentator***

2:15 P.M.—STRIP MINING

CHAIRMAN—R. S. WALKER, ***President, Bradford Coal Co., Bigler, Pa.***

VICE CHAIRMAN—A. E. CODDINGTON, ***Vice President, Carey, Baxter and Kennedy, Inc., Mahanoy City, Pa.***

The Application of Electronics to Surveying & Mining

Over the past five years there have been many innovations in the use of electronics in both field surveying and photogrammetric plotting. These instruments are now beyond the development stage and are saving both time and money in mine mapping.

GEORGE L. HESS, ***Sales Engineer, Aero Service Corp., Philadelphia, Pa.***

Land Reclamation

The coal industry is doing a better job of reclaiming spoil banks than is generally conceded. The record of voluntary reclamation work by coal operators refutes the need for mandatory reclamation.

DR. WALTER H. SCHOEWE, ***Division of Mineral Economics & Coal, University of Kansas, Lawrence, Kan.***

Discussion: C. H. J. BREEDING, ***Field Director, Ohio Reclamation Association, Cambridge, Ohio***

John W. Kraus
President
Imperial Coal Corp.

E. B. Leisenring, Jr.
President
Stonega Coke & Coal Co.

John S. Marshall
President
Pierce Management Corp.

H. E. Mauck
Vice President
Charge of Operations,
Freeman Coal Mining Corp.

D. L. McElroy
Vice President
Consolidation Coal Co.

Joe L. McQuade
President
Donegan Coal & Coke Co.

Maintenance of Strip Mining Equipment

(a) **Wire Rope**

Wire rope maintenance is often a forgotten money saver around strip mines. However, to take advantage of the potential savings in rope costs, a thorough maintenance program must be instigated, starting with an analysis of rope problems.

A. F. MEGER, ***Assistant Chief Engineer, Wire Rope Division, John A. Roebling's Sons Corp., Trenton, N. J.***

(b) **Mobile Equipment**

Good maintenance often spells the difference between profit and loss. Here is how one company gets the most out of a maintenance program.

R. M. LESENEY, ***Mechanical Superintendent, Truax-Traer Coal Co., Fiatt, Ill.***

Earthmoving Equipment as a Supplemental Tool to Stripping Shovels

Over the past ten years, bulldozer design has advanced to the point that these machines are now the prime production machine at many coal stripping operations. Cost keeping procedures, production variations according to terrain, and the theory of bulldozer use in conjunction with revolving excavators will be covered.

C. J. COOPER, ***Instructor in Open Pit Mining, University of Pittsburgh, Pittsburgh, Pa.***

2:15 P.M.—UNDERGROUND HAULAGE

CHAIRMAN—DAVID INGLE, JR., ***President, Ingle Coal Corp., Elberfeld, Ind.***

VICE CHAIRMAN—JOHN W. STRATON, ***General Manager of Mines, The Lorado Coal Mining Co., Lorado, W. Va.***

New Developments in Mine Haulage

(a) **Belts**

This is a report on the status of conveyor haulage today, covering such features as bearings, roller location, drives, idlers and belt. The performance of various types of conveyors in different jobs will be compared.

H. W. MEADOR, JR., ***Division Superintendent, Stonega Coke and Coal Co., Big Stone Gap, Va.***

(b) **Rail**

A change in mining methods dictated a revamping of underground haulage systems for this large coal producer. Haulage at four mines will be de-

E. M. Pace
General
Superintendent
Inland Steel Co.

John A. Persinger
Vice President
Acme Machinery Co.

Edwin R. Phelps
Vice President
Pittsburg & Midway
Coal Mining Co.

E. P. Reed
Manager of Raw Materials
Tennessee Coal & Iron Div., U. S. Steel Corp.

John J. Reilly
Preparation Manager
Jones & Laughlin Steel Corp.

George L. Roberts
Vice President
Simplex Wire & Cable Co.

F. E. Rosenstiehl
Manager
Lubrication Sales Div., Texaco, Inc.

O. A. Schilling
Manager
Industrial Products Div., Goodyear Tire and Rubber Co., Inc.

R. H. Seese
Assistant General Manager
Berwind-White Coal Mining Co.

scribed, presenting several stages of the transition from conveyor mining to rail haulage.

W. H. COGHILL, ***Assistant Chief Industrial Engineer, Mines, Industrial Engineering Department, Republic Steel Corp., Cleveland, Ohio***

A New Development in Shuttle Car Haulage

The shuttle car remains the most important link between the face and the primary mine haulage system and shuttle car design has been keeping pace with loading machine evolution.

JOHN S. TODHUNTER, ***General Manager, Barnes & Tucker Co., Barnesboro, Pa.***

Conversion of Existing Manual Hoists to Automatic Operation

Twenty three years ago Old Ben designed and installed a manual hoist at one of its Illinois mines. It recently moved the unit 24 miles to a new location, redesigned the drums to fit a new duty cycle and depth and converted it to automatic operation.

HOLLIS PIERCE, ***Chief Electrical Engineer, Old Ben Coal Corp., Benton, Ill.***

Haulage System Maintenance

(a) **Belts**

Maintenance is important to this large user of belt conveyors, and preventive maintenance is stressed. Cost figures will be presented to show the benefits of such a program.

BUDDIE R. MORRIS, ***Head, Industrial Engineering Department, West Kentucky Coal Co., Inc., Madisonville, Ky.***

(b) **Rail**

Maintenance of rail haulage systems begins with proper installation of track and trolley. Regular maintenance hinges around good track cleaning—in this case mechanically.

J. S. SCHRENCENGOST, ***Chief Engineer, Allegheny River Mining Co., Kittanning, Pa.***

WEDNESDAY—MAY 11

ALL DAY—TAX FORUM

CHAIRMAN—LINCOLN ARNOLD, ***Chairman, Tax Committee, American Mining Congress***

Discussion of current tax problems of the coal industry—for accountants and others handling tax matters, and all interested mining men.

S. F. Sherwood
President
Stonefort Coal Mining Co., Inc.

H. H. Smith
Manager
Mine & Mill Sales, National Malleable & Steel Castings Co.

N. B. Sommer
Manager
Explosives & Mining Chemicals Dept., American Cyanamid Co.

9:30 A.M.—MANAGEMENT AND COST CONTROLS

CHAIRMAN—R. H. JAMISON, JR., ***President, Delmont Fuel Co., Hunkers, Pa.***

VICE CHAIRMAN—GEORGE McCAA, ***General Manager, Hanna Coal Co., Moundsville, W. Va.***

People

People work for satisfaction—the satisfaction of a job well done and the satisfaction of ample reward. To do his best, then, a man must receive both.

JAMES L. HAYES, ***Dean, School of Business Administration, Duquesne University, Pittsburgh, Pa.***

Personnel Selection—A Panel Discussion

An industrial psychologist, a coal personnel manager and an industry executive discuss ways and means of getting the right man for the right job.

DR. QUIN F. CURTIS, ***Chairman, Department of Philosophy & Psychology, West Virginia University, Morgantown, W. Va.***

C. G. EVANS, ***Personnel Manager, The North American Coal Corp., Cleveland, Ohio***

JOHN N. CRICHTON, ***Executive Vice President, Johnstown Coal & Coke Co., Johnstown, Pa.***

Use of Electronic Computers in Coal Mining—Two Papers

The Coal Division of U. S. Steel has been using an electronic computer in a variety of jobs. These include: quality control of coal preparation plants; the development of production standards; evaluation of the price-quality relationships of coals of various specifications, the process of coal washability data and the development of operating plan balances.

R. D. C. MORRIS, ***Assistant to Vice President—Coal, U. S. Steel Corp., Pittsburgh, Pa.***

W. L. ZELLER, ***Assistant Industrial Engineer, Frick District, U. S. Steel Corp., Uniontown, Pa.***

Wednesday, May 11 (Cont.)

9:30 A.M.—UNDERGROUND POWER

CHAIRMAN—JOHN STACHURA, ***Vice President, Enoco Collieries, Inc., Bruceville, Ind.***

VICE CHAIRMAN—JAMES A. ERSKINE, ***Electrical Engineer, Eastern Gas & Fuel Associates, Pittsburgh, Pa.***

Design of a Power System for a New Mine

Two new coal mines, designed to produce two million tons annually, are being opened in Alabama. A–C was chosen over D–C for the power supply for a variety of reasons which will be discussed.

F. G. HAMNER, ***System Planning Engineer, Southern Services, Inc., Birmingham, Ala.***

Silicon Rectifiers

Performance, design and application of silicon rectifiers for mining service will be covered. Installation and maintenance requirements as well as operating experiences will be discussed.

RALPH E. WAHL, ***Senior Design Engineer—D-C Eqpt., General Electric Company, Philadelphia, Pa.***

Discussion: C. L. SARFF, ***Chief Engineer, Ireland Mine, Hanna Coal Co., Moundsville, W. Va.***

Experience with A-C Mining

This coal company is a pioneer in the use of A–C power. The author will draw on many years experience to show how A–C has permitted savings in maintenance, an improvement in operating time and a better safety record.

OTIS G. STEWART, ***Executive Engineer, Union Carbide Metals Co., Alloy, W. Va.***

Maintenance of Mine Power Systems

Regardless of the publicity A–C mining is getting, D–C power is still with us. Maintenance of D–C power systems, from conversion equipment to face equipment—as well as the proper use of testing equipment—will be discussed.

A. E. MOLINSKI, ***Superintendent of Maintenance, Bethlehem Mines Corp., Johnstown, Pa.***

Extending Trailing Cable Life

A task group of the AMC Committee on Underground Power is studying the various causes of trailing cable failures. A thorough analysis of the failures and complete understanding of their causes can lead to a marked extension in trailing cable life.

Representative of AMC Committee on Underground Power

2:00 P.M.—COAL PREPARATION

CHAIRMAN—W. D. HAMILTON, ***Vice President, Oglebay Norton Co., Cleveland, Ohio***

VICE CHAIRMAN—J. D. SNYDER, ***Chief Engineer, Blue Diamond Coal Co., Knoxville, Tenn.***

Fine Coal Cleaning

(a) **With Heavy Medium Cyclones**

A typical application will be used to emphasize fundamental theory involved in the use of dense medium cyclones. The paper will include a discussion of the quantity of magnetite used to produce a given specific gravity and the consumption of magnetite per ton of product, as well as general remarks on the cost picture.

Representative of Heyl & Patterson, Inc.

(b) **With Feldspar Jigs**

A feldspar jig has proven to be the answer to a small coal producer's problem of washing coal containing 18 to 26 percent reject and 20 percent near gravity material.

R. K. BOGERT, JR., ***President, Badger Coal Co., Philippi, W. Va.***

(c) **With Tables**

Paper will cover the use of tables to clean raw Pocahontas coal. Capacity under various conditions; performance by various zones; efficiency of cleaning various sizes; single deck vs. double deck performance, and required auxiliary equipment will be discussed.

C. W. PORTERFIELD, ***Director of Research-Testing and Sales Liaison, Pocahontas Fuel Co., Pocahontas, Va.***

J. B. Taggart
President
Wise Coal & Coke Co.

C. B. Tillson, Jr.
General Superintendent
Fuel Division,
Crucible Steel Co.

D. W. Vernon
Product Sales Manager
John A. Roebling's Sons Corp.

Charles Vignos, II
President and General Manager
American Mine Door Co.

C. E. Walker
Executive Vice President
Jewell Ridge Coal Corp.

W. L. Wearly
President
Joy Manufacturing Co.

R. R. Williams, Jr.
Manager Mining Department,
Colorado Fuel & Iron Corp.

J. A. Younkins
Assistant General Superintendent
Duquesne Light Co.

Photos Not Available

J. A. Erskine
Electrical Engineer
Eastern Gas & Fuel Associates

James G. McCurry
Vice President and General Manager
Imperial Smokeless Coal Co.

Fine Coal Drying

The thermodynamics of fine coal drying will be considered. A complete heat balance will be developed for a hypothetical fine coal drying problem, and the method of calculating air flow requirements will be illustrated. The effect of varying certain basic conditions, such as moisture to be evaporated, will be discussed as they dictate the size of dryer and auxiliaries.

PAUL LEVIN, ***Project Engineer, Allen & Garcia Co., Chicago, Ill.***

2:00 P.M.—THICK SEAM MINING

CHAIRMAN—C. O. KANE, ***Manager Coal Mines, Armco Steel Corp., Montcoal, W. Va.***

VICE CHAIRMAN—JAMES A. YOUNKINS, ***Assistant General Superintendent, Duquesne Light Co., Pittsburgh, Pa.***

Conventional Versus Continuous Mining Equipment in Seams 38 to 48 Inches Thick

South-East Coal Company has shifted from conventional to continuous mining with a resulting increase in productivity of from 30 tpd per man to 50. The change in mining equipment has brought with it a new approach to mining problems.

HARRY LAVIERS, JR., ***Vice President, South-East Coal Co., Inc., Irvine, Ky.***

Conventional Versus Continuous Mining Equipment in Seams Over 48 Inches Thick

There is a place for both continuous mining and conventional equipment in the coal industry. The choice is dictated by the proper appraisal of all factors involved. Island Creek, in reequipping three mines, chose conventional equipment for two, and continuous mining equipment for the third.

W. F. DIAMOND, ***Manager of Engineering, Island Creek Coal Co., Holden, W. Va.***

Equipment Needs and Trends for Mining in Seams Over 48 Inches Thick

A survey of mining equipment manufacturers has been combined with opinions from coal mine operators and comments from consulting engineers in a report on trends in equipment for the working face, including face and intermediate haulage.

E. H. GREENWALD, ***Partner, Eavenson, Auchmuty & Greenwald, Pittsburgh, Pa.***

Productivity of Continuous and Conventional Mining Equipment

Statistical data will be given showing productivity of mines using continuous mining equipment as compared to those using conventional equipment.

R. L. ANDERSON, ***Commodity Industry-Analyst, U. S. Department of the Interior, Bureau of Mines, Washington, D. C.***

2:00 P.M.—STREAM POLLUTION

CHAIRMAN—LARRY COOK, ***Chairman, Land and Water Use Technical Committee, American Mining Congress.***

A panel discussion outlining the impact of regulations of the Ohio River Valley Sanitation Commission on mining operations in a number of coal producing states.

ERNST P. HALL, ***Research Consultant, Consolidation Coal Co., Pittsburgh, Pa.***

HENRY HEBLEY, ***Research Consultant, Coal Advisory Committee to ORSANCO, Pittsburgh, Pa.***

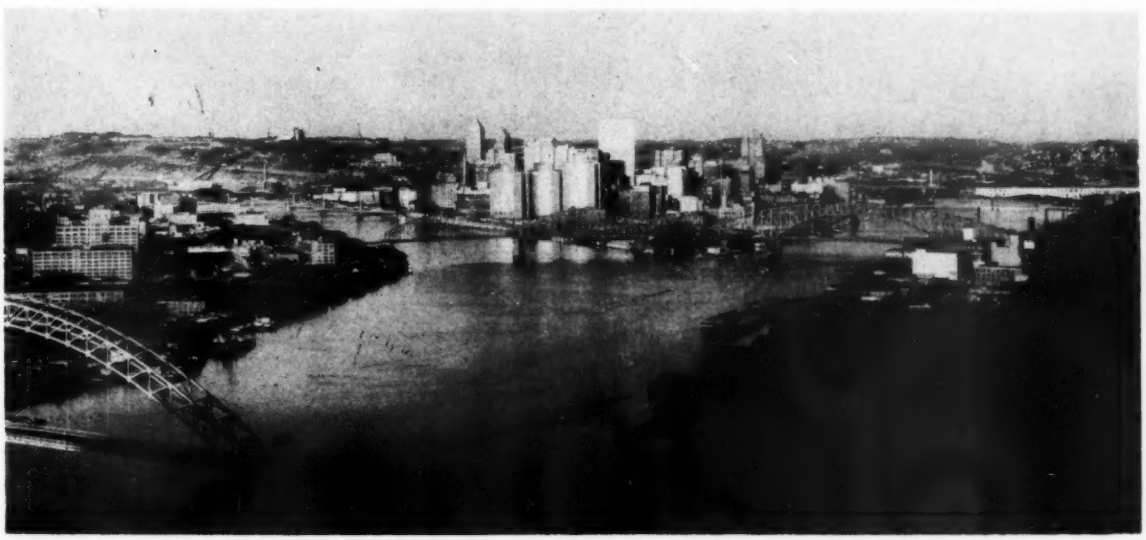
L. E. SAWYER, ***Director of Conservation, Midwest Coal Producers Institute, Terre Haute, Ind.***

Discussion:

7 P.M.—SPEECHLESS BANQUET

TOASTMASTER—ROBERT H. HUGHES, ***Chairman, Program Committee, 1960 AMC Coal Convention***

Brief introductions of honor guests, followed by an outstanding entertainment program.



Pittsburgh's Famous Golden Triangle—Coal Capital of the World

Operators' Corner

WHY CRANKSHAFTS FAIL

Failures are usually the result of external forces created by conditions beyond the control of the manufacturer

By W. E. IRWIN
Caterpillar Tractor Co.

WHEN a major mechanical failure occurs to an engine, it is a natural reaction for the owner to blame the manufacturer. Company representatives, investigating such failures, are often met with such remarks as, "Your engine broke a crankshaft and ruined our torque converter," or "Your engine has failed and we expect you to give us a new engine, or at least a new crankshaft and cylinder block."

Although engine builders often recompense owners for engine damage resulting from crankshafts and other engine components that fail because of "defects in material or workmanship," facts accumulated over the years prove that the odds are heavily in favor of crankshaft failures being caused by some external force or condition.

No matter who builds the engine, crankshafts and bearings are not designed to withstand the extreme stresses that can be exerted on them when various types of power take-offs are misaligned, improperly positioned endwise or so designed that they can exert abnormal forces on the crankshaft.

Recently a relatively new engine on a drilling rig experienced a severe seizure of the rear main bearing which ruined the crankshaft, as well as the cylinder block, causing damage amounting to nearly $10,000. The engine was driving directly into an air clutch and an on-the-job check revealed the inner drum of the clutch was extremely misaligned in relation to the outer drive ring. The extreme

Improper shimming (left), described in text, caused crankshaft failure. The crankshaft broke, as shown, the cylinder block cracked and the rear faces of all the main bearing caps and supports in the block were gouged because of a great forward thrust on the crankshaft. Torsional vibration (right) fractures are characterized by a break at a 45 degree angle, usually toward the rear of the engine

side loads exerted on this engine's flywheel and crankshaft caused the rear main bearing to seize the full length of its bore, generating so much heat that both the crankshaft forging and cylinder block casting cracked beyond repair.

Alignment of air clutches is critical. The higher the air pressure in the boot, the closer the alignment must be to keep the side loads within safe limits. Misaligned air clutches can cause failure to any member to which they are fastened, be it a diesel engine, a torque converter, compound, pump or some other attachment.

In another case, several diesel engines powering torque converter equipped excavators experienced rear main (thrust) bearing failures. The front thrust flange of the rear main bearing became badly scored and, in some cases, broke off. It was found that the power train design allowed the torque converter to exert a linear pull on the crankshaft with thousands of pounds of force under full load conditions. The design was changed by the excavator manufacurer to include a thrust bearing to absorb the pull of the torque converter. And the solid connection of the torque converter shaft to the flywheel was redesigned with the result that bearing and crankshaft failures were eliminated.

Improper shimming caused several thousands of dollars damage to another new engine on a drilling rig. In this case, the engine was driving through a coupling into a torque converter and the torque converter was driving into an air clutch. The coupling between the engine and the torque converter was not properly shimmed to allow the crankshaft to float. Instead, the crankshaft was pushed forward with great force.

The result was that the rear flange of the rear main bearing was broken off completely. The engine was run to destruction as the crankshaft broke through the web adjacent to the rear main bearing. The cylinder block was cracked through the rear bearing web and the rear faces of all the main bearing caps and supports in the block were severely gouged because of the great forward thrust put on the crankshaft.

It was also found that the air clutch, fastened to the output shaft of the torque converter was grossly misaligned which, in all probability, was responsible for complete failure of the torque converter.

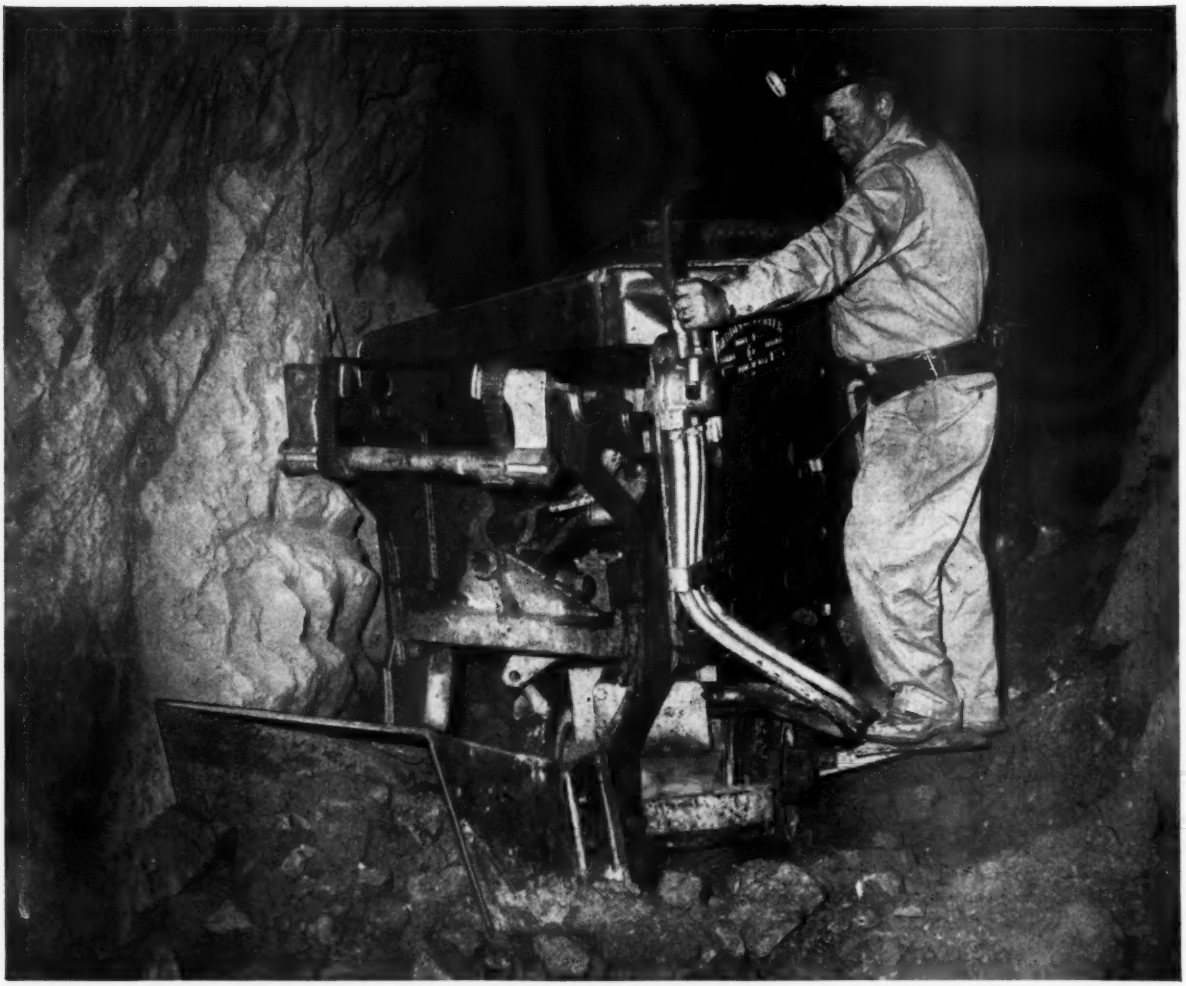
Various physical and metallurgical analyses can be employed to determine if a particular crankshaft failure was caused by manufacturing defects. The type of failure also tells a lot about the cause and gives clues helpful to correcting the problem and preventing recurring failures.

Typical failures:

1. Side loads on the crankshaft can break down the oil film in the bearing, causing seizure. High end loads on the crankshaft not only can score the thrust surfaces of the bearings, but can generate enough heat to reduce the bearing clearance to the point of seizure. Continued running will usually result in a jagged, complete crankshaft fracture near the fillet.
2. High bending type loads, usually from misalignment of driven machinery, can start a crack in the fillet at the main bearing journal which progresses through the web to the adjacent rod bearing journal.
3. Torsional vibration normally fractures a crankshaft at a 45 degree angle. The wide use of torsional vibration dampers keeps this type of failure to a minimum. However, the damper can become overloaded because of added driven equipment or the damper can become damaged. Overspeeding may introduce additional torsional vibrations that can be damaging.

Modern, heavy-duty diesel crankshafts and bearings are not usually manufactured with defects. Failures are usually the result of external forces created by conditions beyond the control of the manufacturer. Physical and metallurgical tests can show whether or not the engine builder is at fault.

High bending-type loads on a crankshaft will usually result in a break which starts in the fillet and progresses through the web



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FAST—exclusive fulcrum design provides faster dumping . . . helps fill longer cars quickly. Wide cleanup range.

HUGS THE TRACK—low center of gravity and high flange wheels for maximum stability, safety.

RUGGED DEPENDABILITY—loader parts are precision-built. Gears and bearings are sealed in, run in oil. Minimum maintenance.

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As Viewed by Henry I. Dworshak of the American Mining Congress

OPPONENTS of pending legislation to establish a vast National Wilderness Preservation System—to be carved out of Federal lands principally located in the West and dedicated to the single use of bird-watchers and other esthetes—were greatly heartened last month by rising opposition in the Senate Interior Committee.

This Committee, three members of which are among the bill's sponsors, has given the measure intermittent consideration for some time. At a recent Committee meeting, Senator O'Mahoney of Wyoming pointed out many pitfalls in the bill and emphatically declared that "a careful reading of this bill would convince anybody that it should be entitled 'A bill to relieve Congress and its Members of their responsibilities under the Constitution,' instead of a bill to create a wilderness system."

O'Mahoney, a Democrat who has served in the Senate for a quarter of a century, then submitted a substitute bill under which Congress would retain its authority over public lands and which would safeguard multiple use of national forest lands placed in the wilderness system. Of particular interest to the mining industry is a requirement in the substitute bill that a recommendation for inclusion of any area in the wilderness system must be accompanied by a report from the U. S. Geological Survey stating that "a geological reconnaissance of such area reveals that it is not prospectively valuable for minerals or other deposits that may be useful for the national defense or the needs of a progressive economy."

Other Senators, including Allott (Rep., Colo.), Bennett (Rep., Utah), and Dworshak (Rep., Idaho), have proposed amendments which would, among other things, safeguard mineral and water development.

★ ★ ★ ★ ★ ★

Washington Highlights

WILDERNESS BILLS: Opposition rising.

COAL RESEARCH: House approves expanded program.

IMPORT QUOTAS: Seaton sees continued need.

WATER POLLUTION: President vetoes higher grants.

LABOR UNIONS: Court upholds harassing tactics.

ACID MINE-WATER: Ohio River Valley guide adopted.

ZINC PRODUCTION: World curbs ended.

ENERGY RESOURCES: Study to be continued.

★ ★ ★ ★ ★ ★

At the end of February, the Committee had not announced when it would again consider wilderness legislation.

EXPANDED COAL RESEARCH WINS HOUSE APPROVAL

Legislation which would give the Federal Government authority to expand and diversify its activities in the field of coal research—long a goal of the American Mining Congress and other spokesmen for the coal mining industry—has been approved by the House and is now awaiting action by the Senate Interior Committee.

The bill would authorize the Secretary of the Interior to set up a special office to contract with State, local and private organizations for research "to encourage and stimulate the production and conservation of coal," with a first-year ceiling on expenditures of $2 million. For later years, however, no limit would be placed on the amount of money Congress could appropriate to carry on the program, which the House Interior Committee has envisioned as lasting 10 years with total expenditures exceeding $50 million.

In its report recommending enactment of the measure, the House Committee emphasized that the new research program should supplement—not supplant—present long-range coal research conducted by the U. S. Bureau of Mines. The Bureau currently is spending at an annual rate of $7.2 million on bituminous and anthracite research, with $7.5 million slated for the coming fiscal year.

According to the Committee report, the bill "provides the basis for a coal research and development program which, if it is adequately financed and vigorously conducted, and if, as expected, it concentrates on short-range projects, will produce results which will substantially improve the economic position of the coal mining industry at large."

The Committee suggested that preference in locating new research projects be granted to areas most severely depressed as a result of shutdowns and unemployment in the coal mining industry.

CONTINUED NEED SEEN FOR IMPORT QUOTAS

Government quotas limiting imports of oil, lead, and zinc should be continued, Secretary of the Interior Fred A. Seaton declared at a recent press conference. Oil quotas, which include the residual product displacing bituminous coal in some of its traditional Eastern Seaboard markets, are needed "for the foreseeable future," Seaton said, and lead-zinc

quotas should be maintained "past the end of this year."

These quotas are fulfilling their purpose of helping domestic producers and, in the case of oil, have tended to increase domestic exploration, he stated. While the domestic lead and zinc mining industries are making a slow comeback under the quota program imposed in 1958, Seaton added, "I don't think we've felt the full impact of the quota system because we still have excess lead and zinc stocks."

Immediate exception to the Secretary's remarks on lead and zinc was voiced by Simon D. Strauss, vice president, American Smelting & Refining Co., a major smelter and refiner of the two metals. Strauss noted that in January the Tariff Commission held extensive hearings on conditions in the lead and zinc industry, including the operation of the quota system, and that the Commission must submit a report to the Senate not later than March 31.

"Under the circumstances it seems strange," Strauss said, "that an official of the Administration would attempt to prejudge the findings of the Tariff Commission. We believe that testimony before the Commission has clearly demonstrated that quotas are detrimental of the long-run best interests of the lead-zinc industry and are highly discriminatory in their impact." He added that "one custom smelter has already been forced to suspend operations, and unemployment in the smelter industry is on the increase."

PRESIDENT VETOES EXPANDED POLLUTION CONTROL PROGRAM

On the ground that water pollution is a "uniquely local blight," President Eisenhower has vetoed a bill which would have authorized an increase in Federal grants to municipalities for assistance in the construction of sewage treatment works from $50 million to $90 million annually, and from a cumulative total of $500 million to $900 million. The House immediately attempted to override the veto, but the vote fell short of the required two-thirds majority.

The veto was no surprise. The President's budget request for this purpose during the coming fiscal year is only $20 million, which in January he said "represents the maximum amount which I believe is warranted for a construction program which is and should remain primarily a State and local responsibility."

In his veto message—the first during the current session of Congress—the President stated that he wholeheartedly favors "appropriate Federal cooperation with States and localities in cleaning up the nation's waters and in keeping them clean," but that the "principal responsibility for protecting the quality of our waters must be exercised where it naturally reposes—at the local level."

Water pollution and its correction are so closely involved with local industrial processes and with public water supply and sewage treatment, he said, that the problem can be successfully met "only if State and local governments and industry assume the major responsibility for cleaning up the Nation's rivers and streams."

As an alternative step to the vetoed bill, the President said he would request Health-Education-Welfare Secretary Arthur S. Flemming to arrange for a national conference on water pollution, to be held next December. "This conference," he stated, "will help local taxpayers and business concerns to realize the obligation they have to help prevent pollution."

COURT RULING UPHOLDS HARASSING BY UNIONS

A unanimous ruling by the Supreme Court has invalidated a National Labor Relations Board order aimed at curbing "harassing tactics" by unions to force employers to bow to bargaining demands in contract disputes. In announcing this decision, which may have far-reaching effects, the Nation's highest court said Congress intended that unions and employers "have wide latitude in their negotiations" unrestricted by Government regulatory power.

At the same time, the Court virtually invited Congress to take another look at the balance of power as it now stands in labor-management contract negotiations, particularly with respect to the effect of union harassing tactics.

Unless Congress acts, many qualified observers are agreed, the effect of the decision is to make legal almost any kind of pressure, short of violence, a union may exert during contract negotiations—provided the union evinces a willingness to bargain in "good faith."

The issue in this case involved harassing tactics directed against an insurance company. When the company's contract with a union expired in 1956, the union did not call a strike but ordered its members to participate in a general work slowdown; the agents refused to write new business, to work scheduled hours, to make required reports, and to take part in company meetings and promotion activities.

Under the court's ruling, according to the NLRB, a union has the power to harass an employer without actually going out on strike. In other words, the union is in the position of "having its cake and eating it too." On the other hand, an employer is faced with the unenviable choice of either shutting down or paying employes while they disrupt his operations.

Nevertheless, the court commented that "We think the Board's resolution of the issues here amounted not to a resolution of interest which the [law] had left to it for case-by-case adjudication, but a movement into a new era of regulation which Congress had not committed to it."

ACID MINE-WATER CONTROL GUIDE ADOPTED

The Ohio River Valley Water Sanitation Commission has adopted an acid mine-drainage control resolution which will become a guide for everyone concerned with this problem in Kentucky, Illinois, Indiana, Ohio, Pennsylvania, Virginia and West Virginia.

A regulatory body set up under terms of an interstate water sanitation compact approved by Congress several years ago, the Commission had been considering such a resolution for some time. Members of the Coal Industry Advisory Committee to the Commission presented a strong case against overly restrictive regulations. As a result, the Commission approved a regulation which agrees that "no practical means of completely eliminating acid mine drainage are yet available."

Coal spokesmen assured the Commission of "the intention of the coal industry to continue its research and experimentation in this field" and offered to cooperate with the Commission in "developing means of ameliorating other pollutional properties of mine drainage which may be proven detrimental."

WORLD GROUP ENDS ZINC PRODUCTION CURBS

At its February meeting in Geneva, Switzerland, the International Lead-Zinc Study Group decided to immediately end volunary restrictions on production of zinc but to maintain those on lead for at least the first nine months of this year.

The 24-nation group, formed some time ago under the auspices of the United Nations, also agreed to set up a committee to continue a review of the situation with regard to the two metals and to hold another meeting in September.

In its report, the Study Group said that market data submitted to it indicated that Free-World zinc production and consumption were about in balance last year. Consumption of zinc, the report stated, ran much higher than earlier estimates and resulted in the improvement in the supply-demand position of the metal. With the prospect of a continuing lead surplus, however, the group felt that continued adjustment of market supplies of this metal was desirable.

ENERGY STUDY TO CONTINUE

A Congressional subcommittee on energy resources will continue an inquiry into the nation's energy resources which it began with hearings in Washington last November, the Joint Economic Committee has announced.

Although the subcommittee concluded, after those hearings, that there was no present occasion for concern about an early shortage in the energy sources necessary to sustain economic growth, it decided to continue the study.

In making the announcement, the Joint Committee said "There has been substantial government intervention at both the State and Federal level. The variety and extent of government regulation, coupled with a complex of relationships, needs considerable study. The partial regulation of natural gas prices and transmission, interstate and intrastate; the insulation of domestic oil prices from foreign competition through import controls; production controls on oil and gas; the direct and indirect subsidies being given to atomic commercial energy; and the division of regulatory responsibility among a number of agencies all suggest the desirability of further careful scrutiny to make sure that the Government itself by its policies is not adding unnecessarily to the economic complexities and uncertainties . . . involved in promoting maximum employment, production, and purchasing power."

Presumably the additional studies will be completed this year.

DON'T FORGET!
1960 AMC COAL CONVENTION
PITTSBURGH, MAY 9–11

personals

Francis Cameron has been elected president of St. Joseph Lead Co. succeeding **Andrew Fletcher,** who was elected chairman of the board. At the same time, the company announced that **Robert H. Ramsey** and **Lawrason Riggs, III,** have become vice presidents, and that retiring vice presidents are **George I. Brigden, R. J. Mechin** and **Felix E. Wormser.**

Vincent D. Perry, vice president and chief geologist of the Anaconda Co., has been elected a director of Green Cananea Copper Co., a 99 percent-owned subsidiary of Anaconda. In his new position Perry succeeds

V. Perry

N. Koepel

Russel B. Caples, who has retired. It has also been announced that **Norbert F. Koepel** was recently elected to the boards of directors of Anaconda's two principal subsidiaries with operations in South America: Andes Copper Mining Co. and Chile Exploration Co. Koepel is vice president of both subsidiaries.

William A. Turner, vice president of the Lake Coal Division, M. A. Hanna Co., recently became president following the retirement of **J. R. Frith.** At the same time, **John Q. Huey** and **George P. Cooper** were promoted to vice presidents of the Lake Coal Division.

Joseph L. Gillson, newly inaugurated president of the American Institute of Mining, Metallurgical and Petroleum Engineers, retired February 29 as chief geologist, Development Department, E. I. duPont de Nemours and Co. Gillson, who has won national recognition in his profession, joined DuPont in 1929 after being an associate professor in the Department of Geology at MIT. He has been succeeded by **Robert M. Grogan,** who will become manager of a newly formed Geology Division in the Development Department. Grogan has been with DuPont since 1951, prior to which he had been a geologist for the Illinois State Geological Survey and a consultant.

J. O. Archer has been elected executive secretary of the Southern Appalachian Coal Operators Association succeeding the late Harry Homan. Archer retired recently as personnel director for Blue Diamond Coal Co. He had been with Blue Diamond for 31 years.

Donald L. Everhart, formerly chief geologist for the Atomic Energy Commission, recently joined International Minerals & Chemicals Corp. as chief geologist in the Mining and Exploration Department. He had been chief geologist for the AEC for ten years.

Charles W. Walker, chief electrician of Amigo Coal Co. for 34 years, has retired. Walker was first employed in coal mines as a trapper at the tender age of eight where he received 45 cents for ten hours of work. His retirement culminates 59 years of working in and about West Virginia coal mines.

Frank S. Black, supervising chemical engineer at the U. S. Bureau of Mines, Albany, Ore., Metallurgy Research Center was recently named a winner of the coveted Arthur S. Flemming Award, given each year to ten outstanding young men in Government. An international authority on extractive metallurgy, Black joined the Bureau of Mines in 1948. In 1958, he was a recipient of the Department of the Interior's Meritorious Service Award.

John W. Krous, executive vice president of Imperial Coal Corp. for the past year, has been named president filling the vacancy created by the advancement of **George E. Owen** to chairman of the board. Before becoming executive vice president, Krous had been general superintendent of mines.

Other newly named officers include: **H. B. Bartley,** vice president; **D. C. Farnsworth,** executive vice president; **H. J. Robert,** secretary; **A. F. Beitel,** assistant secretary; **J. N. Geyer,** treasurer; and **A. C. Ammon,** assistant treasurer.

H. Jacob

H. Myles Jacob has been elected president of Inspiration Consolidated Copper Co., succeeding **Pharic D. I. Honeyman,** who is retiring. Jacob joined Inspiration in 1936 as an accountant and became secretary-treasurer in 1947. He was elected a director in 1953 and two years later became vice president and secretary.

He had been executive vice president since 1957.

At the same time **H. Carroll Weed** was elected a director and vice president of the company. He will continue as general manager. Weed's service with Inspiration began in 1937 as a mine shift boss. He was successively shift foreman, assistant mine superintendent, and general superintendent. Weed was promoted to assistant general manager in 1950 and has been general manager since 1958.

Harold C. M. Gordon, vice president, Dominion Coal Co., Ltd., has been named vice president of Dominion Steel and Coal Corp., Ltd., the parent company.

Three personnel changes at the Brewster, Fla., plant of American Cyanamid Co. have been announced:

Maywood W. Chesson, Jr., has become assistant manager of phosphate operations. He joined Cyanamid in 1947 and has since served as process engineer, mining shift supervisor, assistant mine superintendent, assistant general mining superintendent and assistant to the manager of phosphate operations.

George L. Lyle, Jr., assistant chief engineer since 1957 has been named chief engineer succeeding **W. J. Pace,** who recently retired.

Woodrow W. Lair, former assistant superintendent of the United States Borax & Chemical Corp. potash refinery at Carlsbad, N. M., has been named refinery superintendent. He joined the company in 1946 as a chemist and was promoted successively to research chemist, production foreman and to assistant refinery superintendent in 1958.

N. E. Sylvander has been elected vice president—operations and **Benjamin W. Jones** has been appointed vice president of Pitt-Consol Chemical Co., a wholly-owned subsidiary of Consolidation Coal Co.

Carl G. Hogberg has been appointed president of Michigan Limestone Division of United States Steel Corp. Hogberg, who joined U. S. Steel in 1935 as a blast furnace apprentice, succeeds **Christian F. Beukema.** Beukema had earlier been named president of the company's Oliver Iron Mining Division.

Kenneth A. Waller has succeeded **C. E. Mattox** as purchasing agent, Peabody Coal Co. Mattox retired from the company at the first of the year.

Dwight P. Miller has retired as chief, Reclamation Division, Natural Resources Department, State of Ohio. He supervised reforestation and reseeding of 80,000 acres of strip mine banks in Ohio over the past five years.

H. Ripley Schemm has become president of Huron Portland Cement Co., succeeding **Paul H. Townsend** who was elected chairman of the board.

Clifford J. Hicks recently became western secretary of the American Institute of Mining, Metallurgical and Petroleum Engineers succeeding the late Roy E. O'Brien. Hicks had been senior geologist at the Kelley mine of the Anaconda Co. He joined Anaconda in 1947 as a junior mining engineer.

J. A. Pike has been named manager of Dawn Mining Co., a subsidiary of Newmont Mining Co. Dawn operates the Ford, Wash., uranium processing plant and the Midnite mine on the Spokane Indian Reservation. Before the recent appointment, Pike had been in charge of Newmont Mining Corporation of Canada's Vancouver, B.C., office for ten years. As manager of Dawn, he succeeds **J. J. Crowhurst,** who has become executive assistant to K. J. Springer, Canadian mine developer.

Ronald J. P. Lyon, formerly associated with Kennecott Research Center, recently assumed the position of senior geochemist, Department of Earth Sciences, Stanford Research Institute. He will be responsible for development of research programs in geochemistry, particularly as applied to problems of ore genesis, mineral processing and mineral exploration.

John A. Johnson, chief of the Division of Safety, U. S. Bureau of Mines, has retired. He joined the USBM in 1936 after working for several years in iron mines in the Gogebic and Marquette ranges in the Lake Superior region. He is an authority on underground metal mine fires and explosions.

J. B. Haffner, retired president of the Bunker Hill Co., recently was elected to the board of directors, Day Mines, Inc.

George C. Beals, formerly a smelter metallurgist, Chino Mines Division, Kennecott Copper Corp., has been promoted to project engineer with the company's Western Mining Divisions Engineering Department. He joined Kennecott in 1957 after 2½ years with Cerro De Pasco Corp. in Peru.

E. J. McNamara has been appointed manager of engineering, Freeport Sulphur Co. He had been project manager for construction of the company's Grand Isle offshore sulphur mine.

Vernon L. Mattson has been promoted to manager of mining and milling of Kerr-McGee Oil Industries. He had been manager of mineral development and research at the company's Golden, Colo., research laboratories, and has been with Kerr-McGee since 1955. **Wayne C. Hazen,** research engineer, succeeds Mattson as manager of mineral development and research.

Lawrence B. Berger was recently appointed chief of the newly created Division of Health and Accident Prevention, U. S. Bureau of Mines. He has been with the Bureau since 1920. At the same time, **Donald S. Kingery,** with the USBM since 1941, has been appointed to head the Health and Safety Research and Testing Center at Pittsburgh, Pa.

Charles B. Prebich was recently promoted to superintendent, mechanical maintenance department, Babbitt Division, Reserve Mining Co. He joined Reserve in 1954 as a general foreman and became assistant superintendent in 1959.

OBITUARIES

J. A. Mecia, 42, general vice president of the mining division, Utah Construction and Mining Co., died January 13 as a result of injuries suffered in an airplane crash near Minersville, Utah, several hours earlier. The accident also took the life of **Homer A. Mann,** 49, the company's manager of mining services.

Mr. Mecia had been with Utah Construction since 1952 when he joined the company as manager of the mining division. Prior to 1952 he had been employed by Bradley Mining Co. in Idaho for 11 years. At the time of his death Mr. Mecia was also a vice president and director of Lucky Mc Uranium Co. He was a former vice president of the Uranium Institute of America.

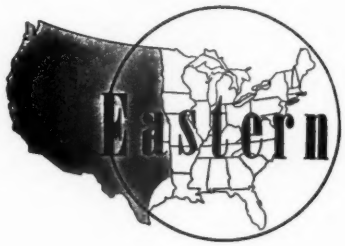
Mr. Mann joined the company in 1952. His mining career began in 1935 in the Philippine Islands with Masbate Consolidated Mining Co. After the Japanese attacked Pearl Harbor, he became a guerilla and served with these forces until he and other Americans were evacuated from Panay in 1944. In 1947, Mr. Mann returned to the Philippines as a consulting engineer with International Engineering Corp. During the Korean Emergency, he was chief, Rare Metals Branch, Defense Minerals Production Administration.

Charles E. Newmeyer, 83, former owner and editor of the Mining Record, died in Denver, Colo., January 28.

Mr. Newmeyer's career with the Mining Record began in 1910. From 1915 until his retirement late in 1959, he was editor of the publication.

Ray N. Wheelock, 62, chief engineer and recently named director of the Engineering Department, Hercules Powder Co., died at Wilmington, Del., early in January. He joined Hercules in 1925 and had been the company's chief engineer for 13 years prior to his death.

NEWS and views



Peabody Joins Curtiss-Wright in New Company

Peabody Coal Co. of St. Louis, Mo., and Curtiss-Wright Corp. of Wood-Ridge, N. J., have formed a new company which will produce a variety of products utilizing bituminous coal.

The Peabody-Wright Corp. will initially construct and operate a small commercial plant for the application of processes developed by Peabody Coal and Curtiss-Wright for the production of chemical coke, heat, low temperature coal tars and coal-based paving binder. Potential sites for the new plant are now under study.

The new company will use a Peabody carbonization process, known as the Mansfield process, which has been under development for the past three years for the production from bituminous coal of chemical coke and low temperature volatile gases. Low temperature volatile gases produced by the Mansfield process will be used in a Curtiss-Wright process for the production of low temperature coal tar which is used in the production of C-W paving binder.

Ted L. Kelce, executive vice president of Peabody, was elected president of the new Peabody-Wright Corp. Members of the board of directors are Ted L. Kelce; Roy T. Hurley, chairman and president of Curtiss-Wright; F. Stillman Elfred, chairman of the board of Peabody Coal; George R. Hill, executive vice president of Curtiss-Wright; William L. Hanaway, of Breed, Abbott & Morgan; and Vaughn Mansfield, chief combustion engineer of Peabody Coal Co.

Philadelphia & Reading to Undertake Chemical Venture Alone

Philadelphia & Reading Corp. is proceeding at once to establish a chemical enterprise that will make use of immense anthracite wastes around Pottsville, Pa. The venture will be undertaken by Philadelphia & Reading alone. This decision by the company's board of directors followed advice from General Dynamics Corp. that its board has decided not to go ahead. The two concerns, under an interim agreement, had been exploring the project together.

Plans for the Philadelphia & Reading chemical subsidiary are based on a number of independent studies which show that the processes involved are technically feasible and profitable. The subsidiary at Pottsville will include a silt-burning power plant and facilities to produce various industrial chemicals derived from acetylene and hydrogen.

Acid Mine-Drainage Control Adopted

A resolution on Acid Mine-Drainage Control was adopted by the Ohio River Valley Sanitation Commission (ORSANCO) at Cincinnati, Ohio, on January 14, 1960. The measure has the approval of the Coal Advisory Committee to ORSANCO, representing the coal industry in the Ohio river watershed. The resolution calls upon the several states which are a party to the compact creating the Commission —Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Virginia and West Virginia (New York has no coal mining) —to place the controls in effect on waters draining into the Ohio river.

No practical means of neutralizing acid mine-drainage, excepting minor quantities in spcific instances, has yet been discovered. The controls being instituted are for the purpose of ameliorating the pollutional effects of these acids. They are the results of research conducted by the coal industry at Mellon Institute and applied experimentally by the industry in the field. A large segment of the coal mining industry in the Ohio river watershed is already carrying out many of the measures being adopted.

The Coal Advisory Committee, in its presentation before the Commission at the January 14 session in which it approved the proposed measures, agreed that no practical means of completely eliminating acid mine-drainage are yet available. The Committee expressed the intention of the coal industry to continue its research and experimentation in this field and offered its cooperation to the Commission also in developing means of ameliorating other pollutional properties of mine-drainage which may be proven detrimental.

Bureau Studies Radiation Effects on Bituminous Coal

Exposure to atomic radiation alters the physical and chemical characteristics of certain coals, but leaves most varieties substantially unchanged, according to the U. S. Bureau of Mines.

Studies by the Bureau over the past two years have shown that coal is remarkably resistant to neutron and gamma-ray bombardment; however, irradiation does make coal harder and this effect might ultimately make possible manufacture of stronger coke.

In certain ranks of bituminous coal, irradiation also disturbs the delicate electrical balance within the coal molecule. This may make the coal react more readily with other materials, and thereby permit improvements in processes for converting coal to liquid fuels and chemicals. However, considerable research will be required to confirm this possibility.

Results of the Bureau's investigation are encouraging enough to warrant further experiments. For example, irradiation might produce entirely different effects on coal that has been mixed with other substances or has been irradiated during processing.

Studies also are planned to evaluate the possibility of using other forms of radiant energy, such as that created electrostatically, by X-rays, or by high-intensity light sources.

At the request of other Federal researchers, the Bureau also has proposed several coal-research projects aimed specifically at developing uses for gamma radiation, which should be available at relatively low cost from spent atomic-fuel elements. Gamma radiation is especially attractive because it does not present the health hazards inherent in radioactivity of coal ash caused by neutron bombardment.

ALSO . . .

A group of Adirondack businessmen have announced formation of the Adirondack Development Corp. with offices in Keeseville, N. Y. Confident that the construction of the Adirondack Northway and the St. Lawrence Seaway will mean a new era of expansion and development, the new organization proposes to do all in its power to promote the great assets of the region. Options have been obtained on a new wollastonite deposit at Lewis, N. Y.; other projects are under study. The development and promotion of the wollastonite deposit will be one of the principle activities of the corporation.

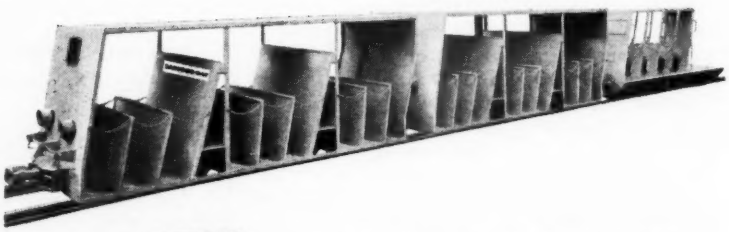
Have an Un-Safe haulage problem? The S-D Brakeman* could be your solution!

We have developed a special safety car called S-D Brakeman. It incorporates electrically operated magnetic brake shoes. Here are but a few S-D Brakeman and S-D Brakeman Personnel and Supply Trains we have engineered and built to solve particular *safety* problems. S-D Brakeman safety control cars can be designed for use with mine or railway cars to solve any number of problems at low cost — underground . . . mainline . . . tipples, etc. Write us today for BULLETIN A400. It fully illustrates in six pages many types of S-D Brakeman Cars with specifications and complete information. *Sanford-Day Iron Works, Inc., P.O. Box 1511 . . . Telephone 3-4191, Knoxville, Tenn.*

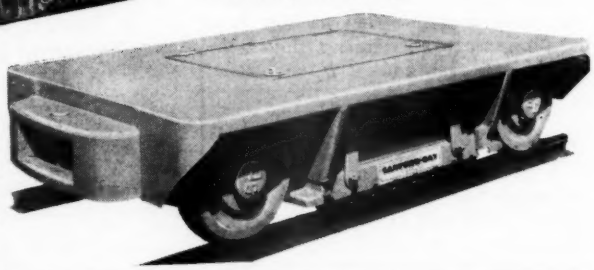
The problem this customer had was with potential break-aways when pulling upgrade on a long uphill haul. This S-D Brakeman *replaced a locomotive and operator* used to tag along behind trip as a safety measure. Controls are set on this 8-wheel S-D Brakeman for a predetermined speed, which, if exceeded, will automatically apply the brakes.

This customer needed cars to transport personnel. Train was to operate by cable on 16 degree slope. *Safe* transportation was the first and foremost consideration. Second important factor was to obtain this safety at *low cost!* An S-D Brakeman was the solution. Not only did it serve as the *safety control car* for the trip, but itself became a dual-purpose man and supply car. Therefore, it further operates independently transporting supplies and maintenance personnel.

Another customer needed an S-D Brakeman Personnel and Supply Train. In his case, however, underground haulageway required low-height train. The two S-D Man Cars are uncoupled from S-D Brakeman at bottom of slope and coupled to conventional locomotive which transports men to working areas. You will note neither design has costly streamlined construction. They are compact all-steel functional units with each steel member an integral part of the frame work. Result: Minimum manufacturing cost which means *you pay less! Safety* at low cost has been the important factor!



Below is another type S-D Brakeman frequently ordered to replace locomotive used in trips for braking.



Pictured below is an S-D Brakeman Personnel and Supply Train designed and built to operate on 17 degree slope by hoist-cable. Note S-D Brakeman was built with material-handling platform to be *level* when transporting supplies on the sloping haulageway. At a pre-determined setting the *revolution of the wheel* applies the *brake shoes.*

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KNOXVILLE, TENNESSEE

To: Sanford-Day, 612 Dale Avenue, Knoxville, Tenn.

Gentlemen, please send by return mail CAR BULLETIN A400 with specifications, data and fully illustrating S-D Brakeman Cars

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Eastern Gas & Fuel Associates will discontinue operations of its coke manufacturing plant in Everett, Mass., effective April 30. Continued operation of this plant was no longer considered economically justified.

United States Gypsum Co. established the best safety record in its history during 1959. It achieved an excellent 1.8 lost-time frequency rating as measured by American Standards Association. Thirty-four of 59 plants enjoyed perfect records.

The Kentucky Department of Economic Development has announced award of a $5000 contract to the University of Louisville Institute of Industrial Research for a six-months study to consider advantages of nuclear radiation and chemical reaction leading to new uses of Kentucky coal. The study is to determine the products obtained when coal is reacted with such materials as ammonia, nitrogen, chlorine, fluorine, steam, hydrogen, oxygen, olefins, and mixtures of these gases. The project is designed to identify proper operating conditions for those reactions which appear favorable as a basis for future laboratory investigations. This contract is part of a large-scale effort of the department and the Kentucky Advisory Committee on Nuclear Energy to use unique research characteristics of nuclear energy to aid the coal industry in developing new products and markets.

BOOK REVIEW

COPPER COSTS AND PRICES: 1870-1957

by Orris C. Herfindahl,

The Johns Hopkins Press, Baltimore 18, Md. $6.00

Published for Resources For the Future, Inc., this 272-page book studies long-term trends in the cost of copper production in the United States.

"The threat of increasing difficulty in obtaining natural resource products has attracted much attention in recent years," according to Herfindahl in his foreword. "But speculation about this possibility often seems to be unduly assertive in view of the lack of pertinent evidence. This study represents an attempt to develop some relevant evidence on cost for one important natural resource commodity and, in the process of doing this, to throw some light on the general problem of long-run cost increase that will be of use in the study of other commodities."

After assessing various ways of getting at the "real cost" of producing copper, the author decides that the most practicable course is by way of deflated price—that is, the historical price adjusted for changes in the general price level which show whether the price of copper moved up or down in relation to all other prices. With further adjustment for abnormal periods when competition was signally ineffective or emergency controls were in effect, Herfindahl maintains that over long periods deflated price is a reliable indicator of real cost. On this basis he concludes that for long periods over the 87-year span covered by the study copper costs in the United States have been quite stable, with steady declines in the grade of ore apparently counterbalanced by technological gains and general advances in business efficiency.

Herfindahl is research associate on the staff of Resources for the Future, specializing in the economics of minerals.

The 32nd annual meeting of Lead Industries Association will be held jointly with American Zinc Institute at the Chase-Park Plaza Hotels, St. Louis, Mo., April 6–8. The first day, Wednesday, April 6, will be devoted entirely to the activities of LIA, evaluating current and new uses for lead. Thursday morning, a joint LIA-AZI session will be conducted at which topics of mutual interest will be presented. Thursday afternoon and Friday will be devoted to the activities of AZI.

Car bodies of steel, alloyed with uranium may provide a new answer to corrosion by salt, and a way out of Canada's uranium problem. The suggestion recently came from W. M. Gilchrist, chairman of Eldorado Mining and Development, the mining company that handles uranium for Canada. He said that "there are several examples known where a few tenths of a pound of uranium, alloyed to a ton of steel, may have a marked effect on its characteristics, and, in particular, on its ability to resist corrosion. It is possible that, used in car bodies, it would help them to resist salt." If this idea stands up to further research, he said, the quantities of uranium required in various fields would be considerable.

Midvale-Heppenstall Co., Philadelphia, Pa., has ordered what it calls the world's largest vacuum melting furnace. It is designed to melt electrodes of alloys and steel which will make 25-ton ingots 40 in. in diameter. Research will be carried out to permit the casting of 60-in. diam ingots. The furnace will have an annual capacity of 8000 tons.

Brush Beryllium Co. is establishing a scholarship program for children of employes. Two $500 scholarships for graduating high school seniors will be made available each year beginning in 1960. Winners who qualify may receive additional $500 annual awards until they have completed four years of college.

West Virginia's share of the Nation's coal production appears to have increased slightly in 1959. Preliminary reports from the U. S. Bureau of Mines shows the state with 29.8 percent of the Nation's coal output, up from 29.0 percent in 1958. The state's total coal production in 1959, still subject to revision, was 115,100,000 tons.

First shipment of aluminum members for a structure to serve the world's highest voltage electric power line has been made by Aluminum Company of America. When assembled, they will form the world's largest aluminum substation, which will serve a power line being built in western Massachusetts. The project will explore the implication of tomorrow's power transmission voltages, looking to a future transmission voltage two or three times today's typical 220 kv.

Inland Steel Co. for the first time is getting iron ore from South America. The vanguard of about 140 barge shipments of Peruvian and Chilean ores started arriving early in January at Inland's Indiana Harbor Works. It also marks the first time the company has received ore by barge. The ore was barged from Burnside terminal midway between New Orleans and Baton Rouge, via the Mississippi and Illinois rivers and Lake Michigan, a trip of 2½ weeks.

A $30,000,000 expansion program was recently approved by the directors of American-Marietta Co. More than one-third of the money will be used to expand the company's lime, magnesite and dolomite production capacity. The program, largest in the Chicago company's history, will be carried out this year.

NEWS and views

Uses For Depleted Uranium Studied

U. S. Bureau of Mines research centers, in cooperation with the Atomic Energy Commission, are studying uses for depleted uranium—a slightly radioactive by-product of enriched uranium produced for the AEC. The studies underway are aimed at finding large volume uses in the metallurgical and petroleum industries.

Among the several investigations, scientists are evaluating the possibility of blending uranium with lead, tin or copper to produce better metal bearings. In another study tests are being conducted to determine if sacrificial anodes of depleted uranium would be more effective than conventional materials in retarding galvanic corrosion, such as in underground pipelines or underwater ship hulls. Because uranium is one of the heaviest materials known, it offers possibilities of being used as a dense medium in mineral separations. Another possible application would be as an alloying agent with steel, where it is contended by some metallurgists, that it would improve the tensile strength of steel. In the form of uranium oxide, its use as a catalyst in refining of shale oil offers promise.

Because most nuclear applications use enriched uranium, the nation has an accumulating stockpile of depleted uranium available for non-nuclear uses.

Alaskan Iron Deposits Tested

By core drilling on the Kasaan Peninsula in Alaska, two Utah Construction and Mining Co. subsidiaries have outlined about 6,000,000 tons of copper bearing iron ores in two deposits that could be mined by open pit methods. Core drilling by Mt. Andrew Mining Co. has shown about 4,000,000 tons of magnetite averaging 40 to 45 percent iron and 0.3 to 0.4 percent copper at one property. From core drilling in the so-called Poorman orebody of Prince of Wales Mining Co., 2,000,000 tons of ore containing 47 percent iron have been revealed. Metallurgical tests indicate production of merchantible iron concentrates and copper concentrates from these ores would be feasible. The deposits are within three miles of tidewater.

Uranium Producers To Merge

Merger of Federal Uranium Corp. and Radorock Resources, Inc., has been approved by directors of both companies. The move, subject to stockholders' approval, would reduce administrative and operating expenditures and would result in immediate tax savings to both, since the two companies have several common interests. This includes the joint venture in uranium mining and milling operations in the Gas Hills area of Wyoming, where the Federal-Radorock-Gas Hills Partners mill was recently completed to process 522 tpd of ore allocated to the Partners by the Atomic Energy Commission.

Federal and Radorock each own equal interest in two companies formed jointly with others in the beryllium field; Dynamic Metals Corp. and Beryllium Resources, Inc. Federal owns 47 percent of outstanding shares of Radorock, and in turn is owned ten percent by Radorock. Merging on a share for share basis, the surviving corporation would have current net assets valued at about $20,000,000 based principally on uranium sales through 1966.

ALSO . . .

Calera Mining Company's 1000-tpd Blackbird mill in Lemhi County, Idaho, has been purchased by Machinery Center, Inc., a Salt Lake City equipment firm, for an undisclosed price. Disposal of the mill came about after the Government discontinued stockpile purchases of domestically produced cobalt.

Exploration, development and mining of thorium and rare metals from 79 claims in Lemhi County, Idaho, and from four claims in Beaverhead County, Mont., will be undertaken as soon as spring weather permits. Agency Creek Thorium & Rare Metals Corp. has reportedly entered into a contract with Rare Metals Corporation of America, a subsidiary of El Paso Natural Gas Co., that will result in development of the claims.

First commercial shipment of uranium ore from the Green Mountain Uranium Co. mine, in the Crooks Gap area of Wyoming, was recently made to the Western Nuclear Corp. mill where it will be processed. Green Mountain has a contract to deliver 580,000 tons of ore to the Atomic Energy Commission prior to the end of 1966.

Millions of tons of lead-zinc ore in the Josephine formation in the Metaline district of Washington could be threatened with inundation under a proposal to build hydroelectric dams on the Pend Oreille River. Northwest power interests have made application to the Federal Power Commission to build dams on the Pend Oreille and hearings were recently held on the proposals. Hearings relative to dam construction on

(Continued on page 107)

AMC
MINING SHOW, 1960
LAS VEGAS OCTOBER 10-13

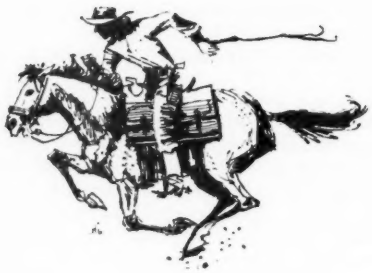
Exposition
Greatest display of machinery and equipment for the metal mining and industrial minerals industries ever assembled

Convention Sessions
Mining executives, engineers, operators, educators, Government officials, members of Congress and other speakers — on the latest developments in all phases of mineral production including industry policy as well as operational techniques

For the Ladies
Luncheon and fashion show, reception at the beautiful home of Mr. and Mrs. J. W. Wells, sightseeing to Hoover Dam and Lake Mead — and plenty of sunshine and relaxation

Trips
Air trip to Kennecott's Nevada operations near Ely — visiting the open pit copper mine, lime quarry, concentrator and smelter
Surface trip to nearby plants of Basic Management, Inc., and to Blue Diamond Co.'s gypsum mine, plaster mill and wallboard plant

Entertainment
Las Vegas offers . . . nuff sed, we leave it up to you!



the Pend Oreille date back to at least 1947. Mining interests have opposed such construction contending the Josephine, an ore bearing limestone formation, would be invaded by reservoir water which would preclude mining.

Aluminium, Ltd., through a recent transaction involving 340,000 shares of Aluminium stock, has acquired Apex Smelting Co. Apex operates a silicon smelter at Springfield, Ore.

Following up earlier exploratory work, it is reported that Idaho Cliffs, a Cleveland Cliffs Iron Co. subsidiary, will core drill iron ore properties that it has leased near Mackay, Idaho.

United States Smelting Refining & Mining Co. recently announced diversification into consulting work, "particularly in the fields of metallurgy, ore dressing, carbon fuels and to provide mine operating and mine management services." The company will handle problems in plant engineering, design, industrial engineering and geological exploration.

Two 1000-ft concrete lined shafts are to be sunk as preliminary work on a $4,000,000 expansion program planned by Duval Sulphur and Potash Co. for their mining operations near Carlsbad, N. M.

Substantial deposits of trona are reported to underly lands that are part of the acreage included in the Bureau of Reclamation's Seedskadee irrigation project in Sweetwater County, Wyo. Stauffer Chemical Co., who reported the discovery, indicates that the deposits are at depths of 600 to 800 ft. Mining of the deposits would, it is felt in some quarters, subject irrigation lands and canals of the Bureau project to possible damage by subsidence.

A $14,000,000 cement plant is to be built at Clarkston, Wash., by Ideal Cement Co. The new plant, which is slated to produce 1,500,000 bbls of portland cement annually, is scheduled to be in operation by late 1961. Raw materials will come from a limestone quarry about 30 miles south of Clarkston.

A 1700-acre tract of land near Morristown, Ariz., is the site of a dry placer gold mill which has been under construction since September, 1959. MacDonald Construction Co., who has taken the properties under lease, built the mill and plans to operate it on a 1500 tpd basis. Other company plans call for opening additional placer operations in the Southwest using similar equipment.

About six square miles of mining claims are reported to have been staked near Tombstone, Ariz., by Bear Creek Mining Co., Kennecott Copper Corp. exploration subsidiary. Bear Creek has been conducting geological reconnaissance in the Dragoon Mountains-Tombstone area in its continuing efforts for finding new copper deposits. Early in 1959, the company acquired a large number of claims near Safford, which was followed in July by filing on about 200 claims near Bowie. The Safford claims have since been under more intensive exploration by Kennecott.

A 15,000 tpd copper flotation concentrator is under construction at the American Smelting and Refining Co. Mission Project near Tucson, Ariz. The mill, which will cost about $17,000,000, is slated for processing 5,400,000 tons of ore per year after it is completed about September 1961. The plant will feature the newest metallurgical techniques, and will employ many automatic measuring and control devices. It is the largest single cost item in the $40,000,000 Mission Project.

Book Review

INTERNATIONAL STRATA CONTROL CONGRESS:

Papers delivered at International Strata Control Congress in Leipzig, October 14–16, 1958. Published by Mining Section of the Academy of Science in Berlin. Distributed by:
Helios Literatur-Vertriebs-GMBH
Berlin-Borsigvalde
Eichborndamm 141–167
Berlin, Germany. $17.50

The book is an outstanding compilation of much of the recent work in the field of rock mechanics. It includes 21 papers by leading European and Russian researchers. In addition to 319 pages of text, the book contains an appendix of dozens of photographs, graphs and line drawings which illustrate many of the notable results of extensive investigation into the action of rock materials under stress.

A synopsis of three papers, which are representative of the 21 papers included, will give the readers a good idea of the subject matter covered in this volume.

Author Saustowicz (Poland) describes certain problems of rock mechanics based on the assumption that rocks act as a visco-elastic or visco-plastic medium. This concept allows due consideration of time as a factor involved in rock deformation.

The writer discusses many simple mechanical models which clearly demonstrate the concepts of elasticity, visco-elasticity, plasticity, visco-plasticity, creep and viscosity. He points out that more accurate analyses of the factors involved in rock deformation can probably be obtained by superposition of these models. This should be the aim of future research.

Kvapil (CSR) summarizes the results of research on rock failure due to: (1) cleavage, (2) plasticity, and (3) splintering. Studies on the phenomenon of plastic flow involved laboratory-produced plastic deformation of various sedimentary rock types. Strips of rock arranged in parallel layers inside lead blocks were subjected to non-uniform loads. After loading, the blocks were dissected and the cross-section exposed for examination. Several photographs reveal model salt dome building, secondary strata displacement and faulting.

Tschernig (Austria) relates that about the beginning of this century, the first rockburst in the Alps was experienced, and mining men gained a preview of the rock pressure problems which were to follow. With the advent of mechanized mining and faster extraction rates, the number of rockbursts greatly increased by the 1930's and the situation became so serious some of the mines had to be closed for safety reasons.

Much of the information concerning rockbursts in the mines of the Alps—a total of over 2500 from 1905 to 1956—has just recently become available. A common concept was that blasting was a direct cause of rockbursts, but the records showed that only 25 percent of the rockbursts occurred during blasting. The data further revealed that although certain levels were especially affected, these levels were not the deepest ones.

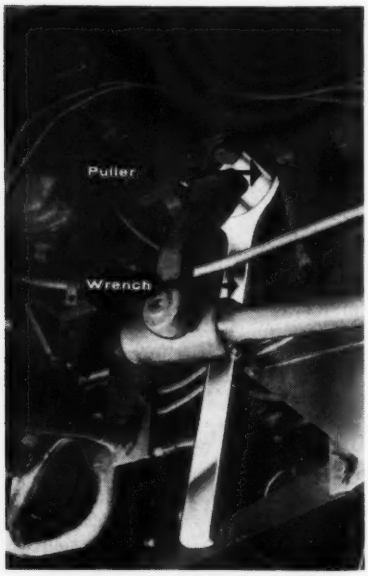
All the observations point to the fact that neither overlying pressure nor its disturbance by working can be the cause for rockbursts. The correct reason was found from a study of the local positions of stress release points. Rockburst points gather along certain lines, almost exclusively northeast faults, and at intersections of faults and mine workings. In fact, some 90 percent of 2500 rockbursts in both the southern and northern Alps were concentrated in the immediate proximity of the north and northeast faults.

The knowledge gained from research into the occurrence of rockbursts has resulted in greatly reducing the number and severity of rockbursts. Furthermore, powder consumption in certain parts of the mines has been cut in half by utilizing rock pressure in new blasting techniques.

manufacturers forum

Arm Puller Set

DESIGNED TO SERVICE the hard to reach, boxed-in pitman arm on "Cab-Over" or "Tilt-Cab" model trucks, the No. 1600 Pitman Arm Puller set is manufactured by Owatonna Tool Co., 653 Cedar St., Owatonna, Minn. The set includes two puller bodies for various pitman arms, and three special puller hex nuts to fit the steering gear levershaft thread size. Any appropriate size wrench turns the hex nut which transmits power to the puller, removing the arm from the steering gear levershaft without damage to parts.



Cutter Bit

A COAL MINING MACHINE cutter bit of new design, with performance improved in three ways, has been announced by Kennametal Inc., Bedford, Pa. It is the Kennametal U17 cutter bit, which is designed to replace the U14 series bits in bit holders that use a steel pin in a neoprene cylinder as a keeper.

A reported feature of the new bit is the position of the gage shoulder at the front of the bit instead of at the back. The knock-out shoulder of the U17 cutter bit has been moved to the back. Cross-sectional area of the new bit shank—with dimensions of $\frac{5}{8}$ by $1\frac{1}{8}$ in.—is approximately 40 percent larger than that of conventional $\frac{1}{2}$ by 1-in. shanks.

Wear on bit blocks and keepers is allegedly reduced because the U17 bit is held more firmly and rigidly in the block than bits previously used. It is said that cutting action is improved by rigid block support against the work. This mounting in the block minimizes harmful shock loads on the cutting tip and reduces strain in the bit shank. Bits can be changed faster and more easily with the knock-out shoulder in the new position. Since this shoulder is now aligned with the keeper, less force is required to remove the bit from the block.

Tip styles for the new Kennametal U17 cutter bit include the cylindrical plug, U17RA; the reversed tip, U17R; and the full nose radius, open-face tip, U17.

Pneumatic Integrator

TO ACCURATELY WEIGH the material conveyed on belts over its continuous weighers, B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R. I., has announced a Pneumatic Integrator called the Integrator-Totalizer which automatically integrates (multiplies) belt travel with belt loading to produce direct readout of the true weight being conveyed.

The device utilizes two components: a precise force-balance positioner and a disc-and-wheel integrator mechanism. The seven-digit totalizer is direct reading in pounds, tons, long tons, etc., and does not need multipliers other than ciphers. Mounted in a dustproof, rubber-gasketed steel case with cast aluminum door, the linear response integrator is highly sensitive, explosion-proof, consumes less than 0.3 Standard cfm of air, and is adaptable for electric contactors for operating remote totalizers.

Device Sequentially Identifies Off-Normals

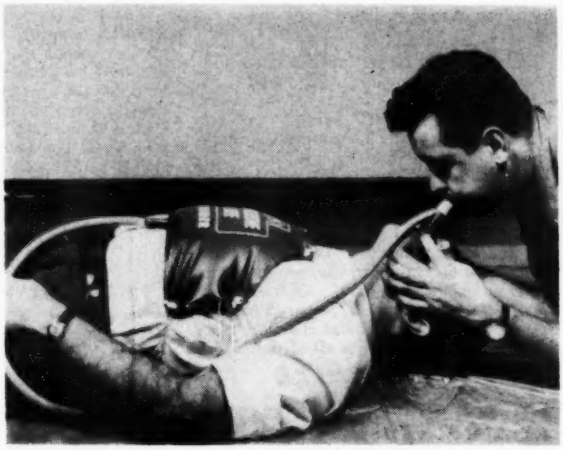
A DIGITAL SEQUENTIAL ANNUNCIATOR which identifies the sequence in which a group of alarms occur has been developed by Panalarm division of Panellit, Inc., 7401 No. Hamlin Ave., Skokie, Ill. Any number of total alarm points report-

(*Continued on opposite page*)

POWERED BY EITHER A GASOLINE OR DIESEL ENGINE, and fitted with a two cu yd capacity bucket as standard equipment, the Cat No. 944 Traxcavator has just been announced by Caterpillar Tractor Co., Peoria, Ill. The company states the "most apparent feature" of the new machine is the locating of all lift arms and hydraulic cylinders ahead of the operator's compartment. This is said to be the first rubber-tired loader "designed from the ground up" to solve this safety problem. Both the gasoline and diesel engines are rated at 105 net hp.

Breathe Life Trainer

DESIGNED TO OVERCOME THE UNSANITARY ASPECTS and personal reluctance of actual mouth-to-mouth contact in practicing this method of artificial respiration, Medical Supply Co., Rockford, Ill., has developed a Breathe Life Trainer.



The equipment consists of a plastic simulated lung worn by the "victim" in chest position. Leading to this is an air tube with plastic mouthpiece which is inserted into the "victim's" mouth as well as that of the person practicing the rescue breathing. It is so constructed that neither person is in contact with the other's breathing or mouth, yet allows the trainee to inflate the simulated lung and hear the "victim's" exhalation. This provides the necessary practice for learning the proper force and frequency of the rescue breath that should be delivered to a victim in case of actual emergency.

It is reported that this equipment can be used to simulate practically every condition where a person is not breathing due to drowning, asphyxiation, electric shock, choking, or suffocation from various causes.

(Continued from opposite page)
edly can be handled. Three variations are available whereby up to 7, 15, or 31 off-normal points may be sequentially identified by clear binary readout, with resolution between points in milliseconds. Model 51-DS is said to be especially valuable in monitoring complex industrial processes where any one or more of many factors can cause automatic shutdown. Alarms are audible as well as sequentially visible. After silencing alarm horn, operator may log off-normal sequence and press reset button to clear board of sequential identification lights. The board is then ready to record sequentially another series of alarms which may occur on the remaining points. Each backlit panel light, however, remains lighted until the device it is monitoring returns to normal.

Miniature Engineering Seismograph

PROVIDING INFORMATION FOR DETERMINING DEPTH to bedrock, the presence or absence of bedrock or other solid materials, and accurate identification of subsurface materials, the 16-lb miniature engineering seismograph is manufactured by Geophysical Specialties Co., 15409 Robinwood Dr., Hopkins, Minn. It is said to afford mine and quarry operators reliable information on subsurface material without costly drilling.

Operation of the instrument requires only two men and can be handled on foot in any type of terrain. In using the machine, seismic impulses are produced by a sledge hammer. An electronic counter circuit measures the time required for sound waves from the hammer blow to bounce off the strata and back to the instrument on surface. Depth and type of material are determined with the instrument readings.

Multiple Woven Hose

ABILITY TO WITHSTAND PRESSURE up to 600 psi, and offered in diameters from 1½ to 6 in., in lengths of 50, 75, and 100 ft, are some of the features advanced by Eureka Fire Hose division, U. S. Rubber Co., for its line of exclusive construction multiple-woven hose and its double jacketed line in 100 percent Dacron construction. The company states that the new Dacron construction completes the changeover from organic to synthetic fibers. Among the advantages cited for the polyester fiber are its resistance to abrasion and chemicals, lightness in weight, flexibility and tensile strength.

—ANNOUNCEMENTS—

Six new sales engineers have been given assignments by the **Equipment Div., National Mine Service Co.,** according to an announcement by sales manager **T. T. Pattison.** Dividing southern West Virginia, will be **Paul W. Smith,** who will operate north of Beckley, and **Elmo Merideth,** who will work south. Northern West Virginia and southwestern Pennsylvania, will be the territory of **Earl K. Gardner,** headquartered in Morgantown. **James J. Ward** will handle Illinois, Indiana, Alabama, and western Kentucky, and **Ronald E. Fink,** Indiana, Pa., will operate in Maryland, New York, Ohio, Pennsylvania (except Uniontown area) and the northern and eastern panhandles of West Virginia. R. Park Lamborn will cover the Mountain States from Salt Lake City.

Jeffrey Mfg. Co., Mining Div., announces the appointment of **J. J. Larry,** Columbus, Ohio, sales engineer, to the position of sales engineer, Beckley Territory, Bluefield, W. Va., district. He is being succeeded in Columbus by **Fred Shafferman** from the St. Clairsville, Ohio, office.

Herman Van Houten, assistant to the president, **Joy Manufacturing Co.,** has been elected general manager of the company's Mining & Construction Division. In his new position, he will administer all sales, service, engineering and manufacturing functions of the division. With broad experience in sales, parts & service, and production, Van Houten has held many administrative positions with Joy and predecessor companies since joining Sullivan Machinery Co. in 1946.

Max E. Colson has been elected vice president of **Atlas Powder Co.,** in charge of the company's Explosives Division, succeeding **W. C. Lytle** who retired at the end of 1959 after 43 years service with the company. Colson joined Atlas in 1935 and had been general manager of the Explosives Division since 1954.

Goodman Mfg. Co., has announced the following appointments in the sales department's belt conveyor division: **J. W. Hardy,** as conveyor analyst; **N. W. Long,** as product manager; and **T. R. Davis,** as sales engineer. The three men will be headquartered in Chicago. Each has had long experience with Goodman products or is a company veteran.

Catalogs & Bulletins next page

CATALOGS & BULLETINS

FILTER CLOTH COMPARISON CHART. *Wheelabrator Corp., 1204 South Byrkit St., Mishawaka, Ind.* A handy comparison chart is now being offered as a guide to the selection of filter cloths commonly used in dust and fume collectors. Cotton, nylon, orlon, dacron and silicone treated glass are classified here according to temperature limits; strength; resistance to acid, alkali, and abrasion; and relative cost per bag.

JAW CRUSHER. *Allis-Chalmers, Milwaukee 1, Wis.* Bulletin 17B6369E depicts 22 modern operating advantages of the *A-1* jaw crusher, and the description includes dimensions and capacity tables on these double toggle crushers with antifriction bearings. Up to 20 percent longer and with up to 35 percent deeper crushing chamber, the *A-1* jaw crusher's required power is reduced through use of a longer pitman and front toggle. Its acute crushing chamber minimizes slippage; longer swing jaw and curved jaw plates reduce packing and provide for closer setting.

VERTICAL MOTOR REDUCERS AND IN-LINE REDUCERS. *Philadelphia Gear Corp., 3620 "G" St., Philadelphia 34, Pa.* Catalog MR-58 deals with motor reducers for use with blowers, compressors, conveyors, cranes, hoists, elevators and similar equipment. The catalog is a complete selection guide, describing construction and mechanical features of motor reducers in eight housing sizes for applications up to 125 hp and output speeds of 9 to 420 rpm. Load characteristics are outlined, including horsepower and torque ratings, overhung loads and maximum allowable thrust loads. Also covered are complete mounting dimensions and parts lists for each type of reducer listed.

SELF-PROPELLED SCRAPER. *LeTourneau-Westinghouse Co., 2301 NE Adams St., Peoria, Ill.* The 28-yd, 360-hp Model B Tournapull—largest self-propelled scraper in the LeTourneau-Westinghouse equipment line—is the subject of brochure (Form No. TP-433) just released by the company. The literature details features of the machine with emphasis upon the choice of various combinations of engine and transmission available; the Power-Transfer differential which automatically shifts power to the drive wheel with the best footing; the instant response electric controls and efficient point-of-action electric motors which perform all of the Model B's steering and work functions.

SLURRY VALVE. *Everlasting Valve Co., 49 Fisk St., Jersey City 5, N. J.* A bulletin is now available describing quick-acting slurry valve which includes such design innovations as an open valve chamber and wedge shaped moving parts. Dimensions of the valve in three, four and six-in. sizes are tabulated along with pressure limits in the brochure entitled, "New Everlasting Slurry Valve."

BIN LEVEL CONTROL SWITCHES. *Stephens-Adamson Mfg. Co., Ridgeway Ave., Aurora, Ill.* Bulletin 159 is now available featuring comprehensive technical and engineering data, specifications, diagrams and illustrations on the normal duty, explosion proof and Heavy Duty "Tellevel" bin level control switches.

MINE MOTIVE POWER BATTERIES. *C & D Batteries Inc., Washington & Cherry Sts., Conshohocken, Pa.* Now available is Bulletin ML-568 which is descriptive of C & D's Accupak plates made with AccuRay control. They reportedly eliminate any possibility of low cells and extend life of C & D heavy duty motive power batteries for operation of mine and tunnel haulage equipment. Illustrations are included of five-fold Slyver-Clad plate wrapping, cell construction, and heavy duty C & D batteries for powering mine locomotives, trammers, shuttle cars, and all types of battery-operated mine and tunnel haulage equipment. Specification charts list the full line of C & D high-capacity batteries from 172 to 2175 amp-hrs.

TRUCK CRANE. *American Hoist & Derrick Co., 63 S. Robert St., St. Paul 7, Minn.* Catalog No. 732-TG-2, which describes the American 200 Series 22½-ton truck crane, uses on-the-job photographs, as well as other illustrations and descriptions, to show time saving features and versatility of the crane.

INDUSTRIAL TORQUE CONVERTERS. *Clark Equipment Co., Automotive Div., Jackson, Mich.* The company's 14, 15, and 16-in. torque converters for industrial power transmission applications are described in Bulletin FFS-5. In addition to descriptions of optional equipment, such as clutch controls, reduction drive, etc., complete power curves for each of the three basic models are provided.

MAGNETIC PULLEYS. *Eriez Mfg. Co., Erie 6, Pa.* Entitled "Erium Powered Permanent Magnetic Pulleys," literature describes Eriez complete line, which incorporates two designs and more and larger sizes than were ever available before.

Index to Advertisers

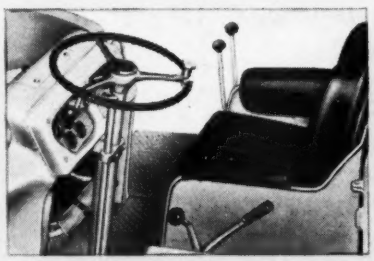
BRIEF SPECIFICATIONS

Bucket capacity, 2 cu. yd.; bucket reach, 50¾ in. (@ 7 ft. dump height); over-all width (bucket), 93½ in.; wheelbase, 88 in.; speeds, forward (4), 0-24 MPH . . . reverse (4), 0-30 MPH; shipping weight, with diesel engine, 20,780 lb. – with gasoline engine, 20,440 lb.

HIGH LIFT, extra-long reach and safety! Note how bucket lift arms are completely in front of operator's area. This gives him new freedom of movement and greater all-round visibility. Other safety features: wide steps for safe and easy access from either side. Plus wide fenders that provide a handy engine checking platform as well as protection for operator from rocks and mud.

NOW! The No. 944

. . . the Cat wheel-type Traxcavator
. . . the first of a New Wheel Loader Line



DESIGNED FOR ACTION, controls provide instant, finger-tip shifting . . . a full range of work and travel speeds with reverse speeds 25% faster than forward speeds. Travel Range gives 2-wheel drive for roading . . . Work Range automatically puts power to all 4 wheels. Other action features: conveniently located machine and bucket controls . . . forward-reverse lever on the steering column . . . both bucket control levers with kick-out devices. Lift control releases at dumping height – tilt control positions bucket for digging.

DESIGNED FOR PRECISE CONTROL, the No. 944 brake system is outstanding. The left brake neutralizes the transmission as it stops the machine to provide superior loading action. The right brake leaves the transmission engaged for full control when creeping, etc.

VERSATILE IS THE WORD for the Cat No. 944 Traxcavator, which is offered with a full line of attachments and accessories to multiply its usefulness to you on any job. Available are forks, cab (shown here) and special buckets, including the exclusive side dump bucket.

Here's the first of a completely new line of equipment . . . the Cat No. 944 . . . rated at 2 cu. yd. capacity . . . that will soon include the No. 922 (1¼ cu. yd. bucket) and the No. 966 (2¾ cu. yd. bucket).

Watch for these new machines with the bold new design . . . they're ready to bring new standards to wheel loader operation. Take a look at the big new features that make this the easiest and fastest wheel loader to operate. Every feature is designed for *efficient work.* Plenty of horsepower . . . finger-tip steering . . . smooth, fast bucket action . . . outstanding operator comfort and safety.

Choose from two great new engines . . . the compact 4-cylinder Cat D330 Diesel Engine, turbocharged for maximum efficiency . . . or the 6-cylinder gasoline engine. Both are 105* HP units. Whatever your requirements, there's a No. 944 powered to meet your needs. Get the complete facts on the No. 944. See your Caterpillar Dealer the week of March 14. See for yourself how the new design pays off on your loader jobs!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U. S. A.

*For comparative purposes, the maximum rating of the Caterpillar D330 Diesel Engine used in the No. 944 is 135 horsepower.

CATERPILLAR

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A GREAT NEW PRODUCT IN THE CATERPILLAR TRADITION

M-S-A® PERMISSIBLE MINE LIGHTING SYSTEMS PROMISE GREATER PRODUCTIVITY AND FEWER ACCIDENTS FOR MINES

Here's significant news for the mining industry: the new M-S-A Permissible Mine Lighting Systems will provide working crews with the first *safe* units for underground illumination since the electric cap lamp.

These systems provide supplementary illumination to electric cap lamps, principally in working areas, to make operation safer and more efficient. They are available in isolated ungrounded two wire and grounded three wire circuits.

Key to the systems is the M-S-A Fluorescent Lamp Fixture. This portable unit utilizes two 14 watt fluorescent tubes and operates from 230 volts, 60 cycles. Also available for operation from 115 volts, 60 cycles. Write for descriptive bulletin.

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